# SELECTED

# **SWATER**RESOURCES ABSTRACTS



VOLUME 24, NUMBER 10 OCTOBER 1991

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# SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey U.S. Department of the Interior

VOLUME 24, NUMBER 10 OCTOBER 1991

W91-09327 -- W91-10468



As the Nation's principal conservation agency, the Department of the Interior has responsibility for most our our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

#### **PREFACE**

S elected Water Resources Austracts, and earlier journal, includes abstracts of current and earlier reports, and elected Water Resources Abstracts, a monthly pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific Information Center U.S. Geological Survey MS 425 National Center Reston, VA 22092

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#### SELECTED WATER RESOURCES ABSTRACTS

#### 2. WATER CYCLE

#### 2A. General

EFFECTS OF SPATIAL ACCUMULATION OF RUNOFF ON WATERSHED RESPONSE, Agricultural Research Service, Durant, Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 2E. W91-09331

STREAM-AQUIFER SYSTEM IN THE UPPER BEAR RIVER VALLEY, WYOMING. Geological Survey, Cheyenne, WY. Water Re-

sources Div

K. C. Glover.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4173, 1990. 58p, 17 fig, 12 tab, 19 ref. Project No.

Descriptors: \*Alluvial aquifers, \*Bear River Valley, \*Streamflow depletion, \*Surface-ground-water relations, \*Water supply development, \*Wyoming, Simulation analysis.

Pumping from aquifers that are hydraulically connected to the Bear River in western Wyoming is likely to reduce flow in the river. Analysis using a likely to reduce flow in the river. Analysis using a finite-element model of the stream-aquifer system near Cokeville, Wyoming shows that approximately 84 percent of pumped water will be derived from water that otherwise would have seeped into the Bear River. The simulation also shows that largest reduction in streamflow is likely to occur which we have the production of the stream of the st during August, which correlates with the period of ourning August, which correlates with the period of maximum pumping, July-August. An analytical streamflow-depletion method applied to pumpage data from municipal wells near Evanston, Wyo-ming shows that reductions in streamflow are likely to occur shortly after pumping begins. The largest changes in streamflow are the result of largest changes in streamflow are the feath of pumping from wells completed in the alluvial aquifer. The effect of pumping from the Wasatch aquifer occurs over a longer period of time. (USGS) W91-09489

NATIONAL WATER SUMMARY 1987-HY-DROLOGIC EVENTS AND WATER SUPPLY

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 6D. W91-09506

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME I: EROSION MODEL FOR DYNAMIC RILL NET-WORKS, PART A-INTRODUCTION AND OVERVIEW, PART B-EROSION MODEL DE-VELOPMENT.

Kentucky Univ., Lexington. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 2J. W91-09519

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME II: HYDROLOGIC MODEL FOR DYNAMIC RILL

Kentucky Univ., Lexington. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2J. W91-09520

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS. VOLUME III: SIMULATION OF RANDOM RILL NETWORK GEOMETRIES ON AGRICULTURAL SOILS. Kentucky Univ., Lexington. Dept. of Civil Engi-

For primary bibliographic entry see Field 2J.

CLIMATIC VARIABILITY AND FLOOD FRE-QUENCY OF THE SANTA CRUZ RIVER, PIMA COUNTY ARIZONA. Geological Survey, Tucson, AZ. Water Resources

For primary bibliographic entry see Field 2E.

TRANSFERRING MODELS TO USERS. For primary bibliographic entry see Field 7C. W91-09570

MULTI-SPECIES RANGELAND HYDROLOG-IC MODEL: PRELIMINARY RESULTS, Agricultural Research Service, Boise, ID. Northest Watershed Research Center west watersned Research Center.

B. P. Wilcox, J. R. Wight, and W. H. Blackburn.

IN: Transferring Models to Users. American

Water Resources Association, Bethesda, Maryland.

1990. p 199-207. 2 fig. 1 tab, 26 ref.

Descriptors: \*Erosion, \*Hydrologic models, \*Model studies, \*Range management, \*Runoff, \*Vegetation effects, ARMS, Computer models, Data processing, Deposition, Hydrologic budget, Infiltration, Land management, Plant growth, Plant populations, Rangelands, Surface runoff, Technology transfer.

Vegetation has a major impact on rangeland hy-drology and erosion. However, few hydrologic models explicitly account for the influence of vemodels explicitly account for the influence of ve-getational dynamics. The ability to simulate multi-species dynamics is important because different species have potentially different impacts on hy-drologic processes. A rangeland hydrologic model has been developed that simulates the growth of multiple plant species. A process-based, multiple species plant growth model has been coupled with a process-based hydrologic and erosional model. Results indicate that two such models can be combined and potentially used to give reasonable esti-mates of plant growth, runoff, and erosion from rangelands. However, the current version of the model is cumbersome and difficult to parameterize. model is cumoersome and unificult to parameterize. Steps need to be taken to simplify the plant growth model, while preserving its ability to simulate multi-species dynamics. (See also W91-09570) (Author's abstract) W91-09590

CLASS--A CANADIAN LAND SU SCHEME FOR GCMS; I, SOIL MODEL SURFACE Canadian Climate Centre, Downsview (Ontario).

Canadian Climate Centre, Downston, University of Climatology IJCLEU, Vol. 11, No. 2, p 111-133, March 1991. 15 fig, 2

Descriptors: \*Air-earth interfaces, \*Atmospheric circulation, \*Climatology, \*Model studies, Boundary layers, Energy equation, Heat transfer, Infiltration rate, Moisture, Snow cover, Snowpack, Soil temperature. Soil water. Surface water.

The land surface areas of the Earth represent significant sources, sinks, and reservoirs of heat and moisture with respect to the atmosphere; the eval-uation of land-atmosphere transfers of energy and uation of land-atmosphere transfers of energy and water is therefore an important component of any general circulation model (GCM). A new GCM land surface scheme has been developed, incorporating three soil layers with physically-based calculations of heat and moisture transfers at the surface lations of heat and moisture transfers at the surface and across the layer boundaries. Snow-covered and snow-free areas are treated separately. The energy balance equation is solved iteratively for the surface temperature; the surface inflitration rate is calculated using a simplified theoretical analysis allowing for surface ponding. Snow cover is modeled as a discrete 'soil' layer. The results generated by CLASS were compared with those of an older model incorporating the force-restore method for the calculation of surface temperature and a bucket-type formulation for the ground moisture. Several month-long test runs were carried out in stand-alone mode. It was shown that the surface temperature in the old scheme responds more slowly to diurnal forcing and more quickly to longer term forcing than that modeled by

CLASS, while its one-layer representation of soil moisture proves incapable of reproducing changes in the surface fluxes owing to surface variations of moisture content. Finally, the lumped treatment of snow and soil in the old scheme results in an extremely fast disappearance of the snowpack under certain conditions. (Author's abstract) W91-09701

IDENTIFICATION OF HOMOGENEOUS RE-GIONS FOR THE PURPOSES OF REGIONALI-

Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering. R. J. Nathan, and T. A. McMahon. Journal of Hydrology JHYDA7, Vol. 121, p 217-238, December 1990. 5 fig, 7 tab, 15 ref.

Descriptors: \*Australia, \*Hydrologic models, \*Mathematical studies, \*Regionalization, \*Watersheds, Cluster analysis, Flow characteristics, Geography, Graphical methods, Heterogeneity, Homogeneity, Model studies, Principal component analysis, Regression analysis.

The problem of identifying homogeneous subregions that can be considered to behave in a hydrologically similar fashion is addressed. The relative performance of several techniques is evaluated using the prediction of low flow characteristics in a heterogeneous group of 184 catchments located in southeastern Australia. Five different approaches were tested for the selection and weighting of variables, to identify the set most relevant to the variables, to identify the set most relevant to the determination of homogeneous regions. The different approaches used are variously based on a combination of cluster analysis, multiple regression, principal component analysis, and the graphical representation of multi-dimensional data. The techniques presented allow assessment of the suitability of applying the derived regional equations to an of applying the cerveet regional equations to an ungaged catchment. This approach has several advantages over existing procedures. It does not assume that hydrologically similar groups of catchments are geographically contiguous. It also clearments whether an ungaged catchment is not similar to any of the available groups; this contrasts with a basic procedure. catchment is allocated to one or other of the groups on the basis of the lowest relative score. Furthermore, it provides the and are allocated. Furthermore, it provides the end user with a clear visual indication of catchment similarity, with two objective criteria being available to aid the ranking and selection of group membership. (Agostine-W91-09720

MODELLING HILLSLOPE WATER FLOW PATHS AND TRAVEL TIMES,

Institute of Hydrology, Wallingford (England). A. Calver, and P. Binning. Journal of Hydrology JHYDA7, Vol. 121, p 335-344, December 1990. 5 fig, 23 ref.

Descriptors: \*Flow pattern, \*Model studies, \*Overland flow, \*Rainfall-runoff relationships, \*Slopes, Hydraulic conductivity, Hydrodynamics, Pore velocity, Saturation, Traveltime, Variability.

A Darcian representation of hillslope water flow is considered to derive flow paths and particle travel times under transient conditions of varying degrees of saturation. A finite element solution of a porous medium flow equation is used to derive specific discharge fields. Interpolation within these fields in relation to nevaline water content allows water. discharge fields. Interpolation within these fields in relation to prevailing water content allows water particles to be tracked within the slope material according to mean pore water velocities, and allows the times of such hillslope travel to be determined. Examples of specific discharge fields, particle tracks and slope base arrival times include:

(1) hillslopes for conditions 5 hr after the start of rainfall; (2) soil of saturated hydraulic conductivities of the charge of the conductivities of the charge of the conductivities of the charge of the char rainfail; (2) soil of saturated hydraunic conductivi-ty, of 0.1 m/hr; (3) non-uniform initial water con-tent conditions; and (4) discharges for the lower 50 m of slope at the start of rainfall, at the end of rainfall, and after a further 5 hr. Where it is reason-able to accept porous medium flow assumptions, the present approach allows systematic investiga-tion of a range of climatic and hydrologic circum-

#### Group 2A-General

stances with estimated or calibrated physical pastances with estimated or canorated pissea parameter sets. In addition to the obvious effect of hydraulic conductivity values on travel times, the preliminary procedural-testing results suggest the great importance of the pre-existing hillslope water content and its spatial distribution. (Agostine-PTT)

RUNOFF CHEMISTRY AS AN INDICATOR OF RUNOFF SOURCES AND ROUTING IN SEMI-ARID, BADLAND DRAINAGE BASINS.

Alberta Univ., Edmonton. Dept. of Geography. D. H. De Boer, and I. A. Campbell. Journal of Hydrology JHYDA7, Vol. 121, p 379-394, December 1990. 8 fig. 35 ref. Natural Sciences and Engineering Research Council of Canada Grant A7968.

Descriptors: \*Catchment areas, \*Overland flow, \*Routing, \*Runoff, \*Runoff forecasting, \*Semiarid climates, \*Water chemistry, Aluminum, Badlands, Calcium, Conductivity, Drainage patterns, Ephemeral streams, Magnesium, Potassium, Sediment concentration, Sodium, Soil types, Storm runoff, Sulfates, Suspended solids, Temporal variation.

The temporal variations of runoff chemistry during a storm event reflect the dynamics of runoff and solute sources. The use of runoff chemistry to investigate runoff generation and routing in semi-arid badland basins drained by ephemeral streams is considered. Discharge, sediment concentration, and electrical conductivity (EC) were measured at the outlets of a 20.2 ha and a 7.9 ha basin. Runoff samples were analyzed for sodium, potassium, calcium, magnesium, aluminum, and sulfate. EC values ranged from 255 to 800 micro s/cm. During the initial phase of flow, EC values dropped sharply owing to the flushing effect. The EC reached a minimum around the time of peak flow, and slowly increased during the falling stage owing to the increased during the falling stage owing to the dissolution of suspended sediment and, during large storms, the influx of solute-rich water from tunnel systems and shale surfaces. Sodium was the dominant cation, and variations of sodium concen-tration were similar to those of EC. The concentrations of the remaining cations showed little variation throughout a storm event. Cation composition was controlled by the displacement of sodium from the exchange sites by divalent cations. Sulfate concentration was strongly correlated with EC, and showed the same pattern of variation through-out a runoff event. Nevertheless, for a similar EC, out a runoff event. Nevertheless, for a similar EU, sulfate concentrations were proportionally lower in runoff from sandstone and pediment surfaces, and proportionally higher in tunnel flow, runoff from shales, and during initial flushing. The sulfate-EC relationship hence proved to be a sensitive indicator of the start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff contents and country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country to the school start of tunnel flow and runoff country tunnel flow and runoff countr generation on the shales, even though each variable had little value when used separately. (Author's abstract) W91-09729

FOREST HYDROLOGIC RESEARCH IN

CHINA.
Beijing Coll. of Forestry (China). Dept. of Soil and Water Conservation X. Yu.

Journal of Hydrology JHYDA7, Vol. 122, p 23-31, January 1991. 33 ref.

Descriptors: \*China, \*Forest hydrology, \*Forest watersheds, \*Hydrologic budget, \*Rainfall-runoff relationships, Canopy, Mathematical studies, Precipitation, Transpiration.

Since the founding of the People's Republic, forest hydrologic research in China has been both unitary and comprehensive. Brief accounts are given of the status and main results of China's forest hydrologic research. Research on water circulation and balresearch. Research on water circulation and bal-scale analysis, including the charting and analysis of water equilibrium and hydrologic elements in small forest watersheds or small forested areas. Water balance was studied in Northeast China's Korean pine woods and cutting-blanks, and on the basis of observations, the distribution relation of all the elements of water balance was described. The hydrologic effects of high-mountain fir woods in

Sichuan Province were observed, and data indicated that in forest water circulation, the runoff is affected mainly by transpiration, which is a key link. In the relationship of forest and precipitation, the canopy interception of precipitation is the first interception by the forest of the rainfall and the first redistribution of the precipitation, which is an important aspect of forest hydrologic research. important aspect of forest hydrologic research. The mechanism of precipitation enhancement by forests is complicated and is an active area of research. Through the theoretical analysis of formulae, it has been concluded that the influence on runoff of forest felling depends mainly on the surface reflection rate, which may become greater these reflects the critical set of the control of the con or less after the cutting, so that the runoff can either decrease or increase after felling. New scien-tific developments continue to find application in forest hydrologic research, to which soil physics, soil-water dynamics, fuzzy mathematics, systems analysis, and the technology of simulated experi-ment research have begun to be used. (Agostine-PTT) W91-09733

TRAVEL TIME OF RUNOFF CRESTS IN

Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2E.
W91-09749

COMPARISON OF INDEX-SEQUENTIAL AND AR(1) GENERATED HYDROLOGICAL SEQUENCES.

Loyola Marymount Univ., Los Angeles, CA. Loyola Marymouni Univ., Los Angeles, Ca. Dept. of Civil Engineering.
D. R. Kendall, and J. A. Dracup.
Journal of Hydrology JHYDA7, Vol. 122, p 335352, January 1991. 14 fig, 2 tab, 33 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Runoff forecasting, \*Streamflow, \*Time series analysis, Colorado River, Comparison studies, Hydrology, Mathematical studies, Reservoirs, Simulation models, Storage.

Many water agencies in California and the rest of the United States utilize sequences of wrapped historic hydrology rather than synthetic stream-flows in their simulation models. The wrapped historic procedure is also known as the index-sequential method. Results from an annual regula-tion model of the Colorado River System which tion model of the Colorado River System which used both historic hydrologic sequences generated be to our instorm hydrology sequences generated by the index-sequential method, and autoregressive, order 1 (AR(1)) synthetically generated streamflows as inputs are compared. The synthetic AR(1) log normal model also included parameter AR(1) for normal model also included parameter uncertainty. Reservoir storage exceedance probabilities developed for Lake Powell and Lake Mead from a 32-year simulation show the AR(1) model generated flows yield slightly higher storage levels at 50% exceedance. This is in part the result of the parameter estimation procedure of the AR(1) model, and also to the fact that AR(1) models do not reproduce critical period severity with the same frequency as that evidenced in the index-sequential method. Thus, the index-sequential method appears to be a conservative approach for average storage predictions. However, for pre-dictions involving higher exceedance probabilities, (i.e. the tails of the distribution) synthetic stream-flows may be more appropriate. (Author's abstraci) W91-09751

NUMERICAL SIMULATION OF INFILTRA-TION AND SOLUTE TRANSPORT IN AN S-SHAPED MODEL BASIN BY A BOUNDARY-

FITTED GRID SYSTEM.
Tokyo Inst. of Tech. (Japan). Dept. of Civil Engi-

For primary bibliographic entry see Field 2G. W91-09753

SOIL-MOISTURE CONDITIONS AND DIS-CHARGE FORECASTING (ETAT HYDRIQUE DU SOL ET PREVISION DES DEBITS). Paris-11 Univ., Orsay (France). Lab. d'Hydrologie

et de Geochemie Isotopique. C. Loumagne, C. Michel, and M. Normand. Journal of Hydrology JHYDA7, Vol. 123, No. 1/ 2, p 1-17, February 1991. 10 fig, 5 tab, 8 ref. English summary.

Descriptors: \*Model studies, \*Soil moisture reten-tion, \*Soil water, France, Rainfall-runoff relation-ships, Simulation analysis, Small watersheds, Stor-

Direct measurements of soil-moisture conditions, which up to now were not included in simulation which up to now were not included in simulation processes, can improve discharge forecasting for a small catchment. In most storage models, it has been shown that because of an inadequate representation of the water yield function at the basin scale, the simulation of discharges was difficult, particularly during transition periods. A comparison has been drawn based on a very simple model. son has been drawn, based on a very simple model applied to the Orgeval (France) catchment, between the classical method of calculating the soil tween the classical method of calculating the soil storage state indirectly and the proposed method which replaces these calculations by measurements of the soil-moisture conditions. The results of the comparison show the superiority of the second method, the first one being unable to translate completely the complex reality of the rainfall-runoff transformation processes. The results show the advantage of including in a forecasting model a soil-moisture condition index which is measured locally at a small timesten during the hydrological locally at a small time-step during the hydrological cycle. (Author's abstract) W91-09776

ANALYSIS OF PERIODICITY IN STREAM-FLOW AND RAINFALL DATA BY COLWELL'S INDICES.

Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering.
K. C. Gan, T. A. McMahon, and B. L. Finlayson. Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 105-118, February 1991. 12 fig, 5 tab, 6 ref.

Descriptors: \*Australia, \*Rainfall-runoff relationships, \*Statistics, \*Streamflow forecasting, Correlation analysis, Monthly distribution, Periodicity, Prediction, Runoff forecasting, Statistical analysis, Time series analysis

Indices of predictability, constancy, and contingency which have been used to describe aspects of cy which have been used to describe aspects of periodicity in biological phenomena were applied to monthly streamflow and rainfall data. The indices were first defined and derived, using a matrix construction with time categories (e.g. seasons, months) as columns and state of the phenomenon months) as columns and state of the phenomenon (e.g. flow classes, rainfall classes) as rows, and the indices calculated using Colwell's formulations. The degree of correlation of the indices with each other, with record length and with the common statistical measures were investigated using 81 monthly streamflow and 73 monthly rainfall records from southeast Victoria, Australia. The three indices are not independent quantities. Predictability is the exact sum of constancy and condictability is the exact sum of constancy and condictability is the exact sum of constancy and con-tingency. Some positive correlation was observed between constancy-predictability and contingency-predictability for monthly rainfall data and be-tween constancy-predictability for monthly streamflow data. This result is expected because as predictability increases, one or both of its components must increase. One disadvantage of predictability and contingency is their tendency to be biased towards the high side for short data lengths. For rainfall data, the following negative correla-tions were observed between Colwell's indices and tions were observed between Colwell's indices and the common statistical measures: predictability-co-efficient of skew, constancy-coefficient of variation, and constancy-coefficient of skew. The fact that these relationships were not observed for streamflow data suggest that they are tenuous, depending perhaps on the type of distribution to which data conforms. For the catchments investigated, increased predictability of streamflow; however, similar relationships were not observed for ever, similar relationships were not observed for constancy and contingency because of the varying proportions that these made up predictability in different time series. (Fish-PTT) W91-09784

#### General-Group 2A

REGIONAL HYDROLOGICAL EFFECTS OF CLIMATE CHANGE. National Technical Univ., Athens (Greece). Div.

of Water Resources.

M. Mimikou, Y. Kouvopoulos, G. Cadavias, and N. Vayianos.

Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 119-146, February 1991. 9 fig, 4 tab, 19 ref.

Descriptors: \*Climatic changes, \*Global warming, \*Greece, \*Greenhouse effect, \*Model studies, \*Mountain streams, Annual runoff, Arid-zone hydrology, Catchment areas, Hydrologic budget, Regional hydrology, Snow, Soil water, Temperature effects, Water resources.

The regional hydrological effects of the expected climate change (i.e. increase of the annual tempera-ture due to the increasing concentration of atmospheric CO2 and other trace gases) and the spatial and temporal redistribution of the regional water resources under various future climatic scenarios were examined by using data of the central mountainous region of Greece, comprising three drainage basins of the Upper Acheloos and the Portaiage assis of the Opper Actions and the Pottal-day of the Water balance type was used, requiring the following types of hydrological parameters: maximum soil mois-ture, watershed lag coefficient, groundwater reservoir coefficient, temperature, minimum rain content coefficient, melt-rate factor, and storm runoff coefficient. It was found that mountainous, snowcovered Mediterranean basins with effective water-retentive characteristics under temperature increase exhibit reductions of soil moisture in gen-eral and more severely in summer, serious reductions of mean annual runoff, even more serious reduction of mean summer runoff and increases of mean winter runoff accompanied by a shift of spring runoff. In warmer, humid basins or in gener-al in basins where regional characteristics limit water retention, a minimal sensitivity of runoff to temperature changes is exhibited. The effects of temperature changes is exhibited. The effects of precipitation change upon the quantities of runoff are characterized by a magnification factor. Basin aridity appears to be positively associated with the sensitivity of runoff to precipitation changes as measured by the magnification factor. Snow (accumulation and melting) is the most significant and determining factor of basin response to climatic change, which in turn depends on the orographic characteristics of the besin besides the general clicharacteristics of the basin besides the general cli-matic ones. Additional characteristics were shown to be important, such as the coefficient of runoff which, when unusually high, does not permit other hydrological processes, sensitive to climatic change, to be completed or even to take place at all. (Fish-PTT) W91-09785

EFFECT OF IRRIGATION ON DAMBO HY-DROLOGY: A CASE STUDY. Loughborough Univ. of Technology (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 4A. W91-09786

HYDROLOGICAL RESPONSE OF THE ALLT A'MHARCAIDH CATCHMENT-INFERENCES FROM EXPERIMENTAL PLOTS. Imperial Coll. of Science, Technology and Medi-

cine, London (England).
H. S. Wheater, S. J. Langan, A. Brown, and M. B.

Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 163-199, February 1991. 21 fig, 5 tab, 27 ref.

Descriptors: \*Catchment areas, \*Hydrologic cycle, \*Hydrologic models, \*Rainfall-runoff relationships, \*Runoff plot, \*Scotland, Flow pattern, Hydrologic properties, Peat soils, Slopes, Tensiometers, Water table fluctuations.

Recent interest in upland water quality has placed increasing importance on the determination of hy-drological flow paths; since these cannot be identi-fied uniquely from catchment-scale observations, ned binquery irons caterine and constraints are process studies are required, necessarily undertaken at plot scale. Experimental plot studies were undertaken at the Allt a Marcaidh catchment, Scotland, in which three-dimensional automatic

tensiometer arrays were used to identify plot re-sponse, and plot sequences were considered as a basis for the definition of larger-scale response. basis for the definition of larger-scale response. Results were examined for five plots on two hills-lope sequences. On an extensive linear peaty-podzol slope, a highly heterogeneous response was observed. Water table conditions occur at the profile base and, locally, near the surface. Spatially localized transient mid-profile response suggests the generation of preferential flow paths. At the base of the peaty-podzol slopes, classical expansion and contraction of water table conditions were observed in association with seen generacce at and contraction of water table conditions were observed in association with seep emergence at localized topographic features; however, transient response associated with preferential flow paths was also indicated. Peat soils on more gentle slopes were generally near saturation with water table elevations determined by the microtopography of erosion features. The bulk of the peat matrix was not responsive to storm events, but dynamic response was transmitted from upslope at the base of the profile. Catchment-scale response is hypothesized as an integration of the plot and hillslope-scale observations. The prospect for a priori modesized as an integration of the plot and hillslope-scale observations. The prospect for a priori mod-eling of such systems appears bleak. There would seem to be no alternative at present to the use of catchment-scale data to infer process representa-tion, with all the associated problems of ambiguity in parameter estimation. (Author's abstract) W91-09787

CLIMATE AND STREAMFLOW VARIABILITY RELATED TO WATER SUPPLY IN THE WESTERN UNITED STATES.

Colorado State Univ., Fort Collins. Dept. of Atmospheric Science. For primary bibliographic entry see Field 2B. W91-09824

APPLICATION OF A DISTRIBUTED-ROUT-ING RAINFALL-RUNOFF MODEL TO FLOOD-FREQUENCY ESTIMATION IN SOM-ERSET COUNTY, NEW JERSEY, Geological Survey, Trenton, NJ. Water Resources

For primary bibliographic entry see Field 2E. W91-09845

HISTORY OF THE WATER RESOURCES DI-VISION OF THE UNITED STATES GEOLOGI-CAL SURVEY: VOLUME V, JULY 1, 1947, TO

APRIL 30, 1957. Geological Survey, Reston, VA. For primary bibliographic entry see Field 10F. W91-09856

NUTRIENT INPUT-OUTPUT BUDGETS OF TROPICAL FOREST ECOSYSTEMS: A TROPICAL REVIEW.

Vrije Univ., Amsterdam (Netherlands). Dept. of Hydrogeology and Geographical Hydrology L. A. Bruijnzeel.

Journal of Tropical Ecology JTECEQ, Vol. 7, No. 1, p 1-24, 1991. 2 fig, 1 tab, 111 ref.

Descriptors: \*Tropical regions, \*Forest ecosystems, \*Forest hydrology, \*Nutrient budgets, \*Soil fertility, Calcium, Magnesium, Potassium, Phosphorus, Nitrogen, Review, River basins.

Atmospheric gains and hydrologic losses of calcium, magnesium, potassium, phosphorus and nitro-gen for 25 tropical forest sites on a variety of geological substrates are reviewed. The data set compressed 19 lowland and 6 montane sites. compressed 19 lowland and 6 montane sites. Twenty studies were subjected to further analysis after initial quality control. These were subdivided into forests on (1) very fertile soils (N = 5), (2) moderately infertile soils (N = 4), (3) moderately fertile soils (N = 4) and (4) fertile soils (N = 4). Two studies pertaining to large river basins were treated separately. Although variation in nutrient fluxes was large, reflecting both natural and methodological factors, scatter plots of annual calcium, magnesium and potassium losses  $\nu$ , annual runoff magnesium and potassium losses v. annual runoff for small catchment areas revealed four groups with characteristic nutrient export patterns that corresponded closely with soil fertility levels. Elelosses from two large basins were much

higher than those recorded for small basins in the ne areas and were interpreted in terms of depths of weathering front, river incision and root net-work. Phosphorus accumulated in virtually all cases, reflecting the low mobility of the element. cases, renecting the low mobility of the element.

Nitrogen budgets were generally very incomplete.

There is a need for more studies on tropical nutrient budgets, especially nitrogen. Standardization of methodology is essential if comparability of results is to be improved. (Author's abstract)

W91-09933

COMPUTATIONAL HYDROLOGY '87. For primary bibliographic entry see Field 7C. W91-10018

MODELING SNOWMELT-RUNOFF AND LAKE EVAPORATION USING SATELLITE DATA.

Brigham Young Univ., Provo, UT. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C.

APPLICATION OF MICROCOMPUTER PRO-GRAMS FOR PEAK DISCHARGE CALCULA-

North Carolina Univ. at Charlotte. Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-10023

DEM DATA USED TO DEVELOP RUNOFF IN AREAS OF DEPRESSIONAL STORAGE. Bureau of Reclamation, Billings, MT. For primary bibliographic entry see Field 7B. W91-10055

WATER FOR THE FUTURE; HYDROLOGY IN PERSPECTIVE,

Proceedings of the International Symposium on Water for the Future held in Rome, April 1987. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. 517p. Edited by J. C. Rodda and N. C.

Descriptors: \*Future planning, \*Hydrology, \*Symposium, \*Water demand, \*Water resources management, Conferences, Data acquisition, Data interpretation, History, Hydrologic data, Hydro-logic models, Water management, Water resources

Water for the future is a topic that must concern everyone. The need for assessing the demands of the future on our water resources is of pressing concern to hydrologists as well as to hydraulic concern to hydrodisis as were as to hydraunic engineers. Therefore, a symposium was jointly convened by the International Association of Hydrological Sciences (IAHS) and the International Association for Hydraulic Research (IAHR). The proceedings of the symposium is contained in two volumes and includes a wealth of material on hyvolumes and includes a wearth of material of hy-drology and water resources. The volume on hy-drology contains papers addressing the following subjects: the rise of understanding in hydrology, advancement of data capture and manipulation, impact of advances on water development and management, organizational development and management, organizational developments in hydrology, the thrust of thought in contemporary hydrology, and new techniques in data capture. Specific subject matter ranges from historical studies to highly technological model studies to views for the future. (See W91-10104 thru W91-10149) (Fish.PTT) (Fish-PTT)

VARAHAMIHIRA, THE EARLIEST HY-DROLOGIST.

Nagpur Univ. (India). Dept. of Geology. For primary bibliographic entry see Field 10F. W91-10105

#### Group 2A-General

NEW STAGE OF DEVELOPMENT OF HYDROLOGY-WATER RESOURCES HYDROLO-

Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China). J. Chen.

IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 17-25, 1 fig. 1 tab, 4 ref.

Descriptors: \*History, \*Hydrologic cycle, \*Hydrology, \*Water demand, \*Water resources development, \*Water resources management, \*Water use, Economic aspects, Environmental engineer-Hydraulic engineering, Hydrologic aspects,

The establishment of the hydrological cycle and the water balance concepts was a significant land-mark in the process of the development of hydrol-ogy and might be taken to indicate the appearance of the stage which could be called Geographical Hydrology. The need for hydraulic engineering structures demanded quantitative analysis and the determination of characteristics of different hydrodetermination of characteristics of different hydro-logical phenomena, and this brought about the occurrence of Engineering Hydrology. Engineer-ing Hydrology together with Geographical Hy-drology enrich the content and the practical sense of the hydrological sciences. Social development promoted the increase in water demand and the development and utilization of water resources on a large scale; meanwhile the breakthrough of prodern techniques promoted hydrology and transa large scale; meanwhile the breakthrough of modern techniques promoted hydrology and transformed it into a new stage of development: Water Resources Hydrology. This stage is characterized by the need to deal with water resources analysis and rational management, and now hydrology involves not only the problems of natural sciences and technical sciences, but also those of the social sciences, Some of the components of Water Reand technical sciences, but ano those of the social sciences. Some of the components of Water Re-sources Hydrology include water resources assess-ment, systems analysis of water resources, environ-mental hydrology issues, hydrological simulation and modeling, hydrological automatic monitoring systems, and hydrological automatic monitoring systems, and hydrological and water resources computerized databases. Water Resources Hydrology provides the scientific basis for the exploitaand protection of water resources for the sake of obtaining optimal economical and social benefits, but continuing the utilization of water resources for the welfare of the people. (See also W91-10103) (Author's abstract) W91-10106

DEVELOPMENT OF THE HYDROLOGICAL CYCLE IN THE WESTERN WORLD: HOW IT IS TAUGHT IN FRANCE, YESTERDAY AND TODAY (RAPPEL DE L'HISTORIQUE DU CONCEPT DU CYCLE DE L'EAU DANS LA CULTURE OCCIDENTALE: SON ENSEIGNEMENT EN FRANCE, HIER ET AUJOURD'-HIID. HUD.

Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). Lab. d'Hydrolo-

For primary bibliographic entry see Field 9A. W91-10108

THREE STAGES OF WATER ECONOMY (LES TROIS STADES DE L'ECONOMIE DE L'EAU). Bureau de Recherches Geologiques et Minieres, Orleans (France).

Orieans (France).

J. Margat.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 47-51, 8 ref.

Descriptors: \*Environmental effects, \*Future planning, \*History, \*Hydrology, \*Water resources development, \*Water use, Developing countries, Economic evaluation, Industrial development, Legal aspects, Semiarid lands, Social aspects.

A historic overview of the relation of man to water in nature is relevant to a discussion of man's water prospects for the future. It seems possible to distinguish three stages in the practice and theory of water balance, its legal aspects, and cultural

perception. (1) For millennia, water was an ele-ment of the biosphere just like all the others and mankind did not significantly modify the hydrolog-ic cycle or natural equilibria--one could call this traditional period 'the aquatic age'. (2) The 'hy-draulic civilizations'--which slowly developed out of necessity in semi-arid regions and were the first examples of human mastery of water--were precurexamples of numan master) of water-were precur-sors of 'the hydraulic age' which was a particular feature of industrialized societies. (3) The limiting, often critical, situations which frequently occur in developing countries, in which options are dimin-ished due to the intensification of water utilization and because of consequent damage to the environ-ment, represent a new stage which can be associated with 'post-industrial' societies. Now, hydrologists are more and more extending the applications of the hydrologic sciences beyond the mere physi-cal evaluation of resources--and risks--and have already begun to deal with the management and economic evaluation of the sensitivities of the environment and to determine society's options for its conservation. (See also W91-10103) (Fish-PTT) W91-10109

NONPARAMETRIC TECHNIQUES FOR ANALYSIS OF HYDROLOGICAL EVENTS. Ottawa Univ. (Ontario). Dept. of Civil Engineer-

K. Adamowski.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 67-76, 3 fig, 2 tab, 14 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Numerical analysis, \*Probabilistic process, \*Probability, \*Statistics, \*Theoretical analysis, Canada, Estimating equations, Ontario, Parametric hydrology, Regression analysis.

ndamental problem in hydrology is to develop models, based on a sample of observations, that can describe the probabilistic nature of hydrologic phenomena. Many models require knowledge of the probability density function (PDF), whereas others are based on regression techniques. Both types of models have been traditionally analyzed by parametric methods, whereby the data are assumed to follow a particular parametric family, i.e. log-Pear-son III distribution, linear regression, etc. The problems encountered in the parametric approach are well recognized, and lead to subjective, inaccurate, non-robust, and non-uniform analysis. Under these circumstances one might take recourse to onoparametric modeling. The nonparametric methods of PDF estimation and regression analysis are particularly powerful and their potential applications in hydrology are very attractive. The nonparametric kernel estimation of probability density function consists of placing an assumed kernel function at each observation, and the summation of these kernels with suitable determined value of the smoothing factor (or bandwidth), h, gives the density function. Some of the advantages of the nonparametric method include: the shape of PDF is not a priori assumed, the method is parsimonious (i.e., only one parameter, h, is computed from the data), the method is robust in the presence of outliers and, uniform whereby no assumption is made with respect to a particular parametric PDF or parameter estimation method. For numerical analysis, four parametric distributions (all accepted by chi-square test at 5 and 1% significance levels) and the nonparametric method were applied to the Northeast Margaree River in Ontario, Canada. The results show that the nonparametric method gives smaller bias and smaller root mean square error than the log-Pearson type III distribution used in simulation study. From this limited study, it is evident that the nonparametric method is accurate, uniform, and particularly suitable for multi-modal densities. (See also W91-10103) (Fish-PTT)

HYDROLOGY OF COASTAL LOWLANDS-ANALYSIS OF PROBLEMS AND RESEARCH

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington,

DC. 1987. p 215-228, 1 fig.

Descriptors: \*Coastal marshes, \*Coastal zone management, \*Estuarine, \*Estuarine environment, \*Land management, \*Wetlands, Coastal waters, Flood plain management, Industrial development, Saline water intrusion, Silting, Soil erosion, Urban

In spite of high risks and unforeseen dangers, people have settled in coastal lowlands for many centuries. The rapid growth of the world's populacenturies. The rapid growth of the visit of the tion which is expected will cause further pressure on land in these regions for the production of food as well as for urban and industrial development. In as well as for urban and industrial development. In his perspective, the role of water-and so of hy-drology-is evident. The main headlines of future hydrological research in this area can be found by analyzing on the one hand the needs in society and demands for the further intensification of the hy-drological sciences, and on the other hand, the hydrological questions in coastal lowlands. On the basis of such a confrontation, research needs are basis of such a confrontation, research needs are formulated on social and general hydrological as-pects, water supply and water conservation, ero-sion and sedimentation. The International Associa-tion of Hydrological Sciences (IAHS), with its Commissions, and the Fourth phase of the Interna-tional Hydrological Programme of UNESCO may also as important social in further studies involving play an important role in further studies involving integral (regional) studies in coastal lowlands, the integral (regional) studies in coastal rowands, the effects of a possible rapid rise of the mean sea level on the hydrology and water management of coastal areas, salt water intrusion in open estuaries, drainage conditions of coastal wetlands, soil erosion upstream and silt processes in the downstream river reaches, and flux of polluted silt and pollution of flood plain soils. (See also W91-10103) (Fish-W91-10124

INVOLVING HYDROLOGICAL RESEARCH IN LAND USE IMPROVEMENT.

Institutul de Meteorologie si Hidrologie, Bucharest (Romania). For primary bibliographic entry see Field 4C.

W91-10128

HYDROLOGY IN ZIMBABWE--THE PAST AND THE FUTURE.

Ministry of Energy & Water Resources, PO Box 8132, Causeway, Zimbabwe. P. Wurzel.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 265-278, 6 fig. 39 ref.

Descriptors: \*Developing countries, \*Groundwater resources, \*History, \*Hydrologic data, \*Surface water, \*Water resources development, \*Water resources management, \*Zimbabwe, Africa, Boreholes, Flood data, Flow measurement, Geophysical methods, Radioactive tracers, Rainfall-runoff relationships, Remote sensing, Research priorities.

The 'state of the art' in water resource development in Zimbabwe was surprisingly well-advanced at its time of independence. The earliest records of runoff are available from 1912, and the first attempt to relate rainfall to runoff was made in 1927. By the 1950s the building of flow-measurement devices had begun, and, in the 1960s, research was under way on rainfall-runoff relations, afforestation effects, evaporation suppression, sedimentation, seiche effects, new techniques of streamflow and floodflow measurement, computerization of hydro-logical information, and use of radioactive tracers. In the 1970s, significant contributions were made in flood analysis. Economically-accessible groundin flood analysis. Economically-accessible ground-water of depths less than 100 m forms the largest single source of water supply in Zimbabwe; how-ever, until recently, groundwater has been one of the neglected fields of hydrology. Despite the fact that in the past 50 years approximately 40,000 boreholes (mostly for domestic use) have been drilled, relatively little is known about this vital resource. Since 1976, borehole records have been computerized and analyzed to vield a first order computerized and analyzed, to yield a first order approximation of mean yields and depths in differ-

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ing rock types. The favored method for ground-water location has been the electrical resistivity technique and 75% of all government-drilled bore-holes have been sited by this means. However, it appears that this method has minimal prediction value in shallow groundwater exploitation. Nuclear techniques in groundwater hydrology were first attempted in 1964. There exist very little data on attempted in 1964. There exist very little data on groundwater quality; in only two areas has a generalized water quality picture been developed. As a result of the lack of systematic groundwater level data, little is known of recharge rates into the different groundwater basins. Prospects for the future are exciting. Zimbabwe, unusual for a developing country, has now a nuclear isotope capability in groundwater and surface water hydrology; a major remote sensing facility is planned and foreign donor aid is being utilized to provide a substantial hydrological database. (See also W91-10103) (Fish-PTT) W91-10129

#### COLLECTING, PROCESSING, STORAGE AND ANALYSIS OF SELECTED HYDROLOGICAL DATA IN SWITZERLAND.

Service Hydrologique National, Bern (Switzer-

For primary bibliographic entry see Field 7B. W91-10130

#### INPUT OF SYSTEMS SCIENCE TO HYDROL-

Polish Academy of Sciences, Warsaw. Inst. of Geophysics. Z. W. Kundzewicz.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 331-339, 1 fig, 10 ref.

Descriptors: \*Control systems, \*Electrical engineering, \*Hydrology, \*Model studies, \*Systems analysis, \*Theoretical analysis, Automation, Computers, Data processing, Dynamic programming, Linear programming, Optimization, Systems engineering.

Several theoretical concepts that were originally developed in electrical engineering have proved useful in the hydrological sciences, such as 'systems science,' also known as cybernetics, systems engineering, automation, automatic control, or control theory. The impact of systems science on hydrology and water resources has been analyzed. nyuriogy and water resources has been analyzed.
The three recognized epochs of the development
of system science contain concepts and elements
useful in hydrological sciences. The first epoch of
systems science has been labeled the era of servomechanisms and transfer functions, with the principal problem to keep the regulated variable (usually par protein to deep the regulated variable (usually one-dimensional) at a constant value using feed-back control in response to dynamic error. This principal philosophy found immediate applications in the regulation of storage reservoirs, i.e., maintaining a constant volume of stored water by an appropriate discharge in reaction to the inflow. The birth of the second epoch accompanied the The birth of the second epoch accompanied the requirements of precision guidance and control, precise estimation of trajectories in space flights (where several state variables were of interest), and also increasing availability of more powerful digital computers. The two main directions of development were optimal control (used for optimizing reservoir discharges, flood wave control, joint control of groundwater and surface water resources, and irrigation procedures) and linear filtering (used for on-line real-time forecasting and adaptive parameter estimation for studies of raintering (used for on-line real-time forecasting and adaptive parameter estimation for studies of rainfall-runoff relations, flood routing, water quality, and groundwater). it is speculated that the third epoch will take into account new achievements in computer science and technology, and use information in non-equipmental and in non-equation. computer science and technology, and use intor-mation in non-numerical and in non-equation forms, holding considerable prospects for hydrolo-gical application to large systems. It is believed that the existing ties between hydrology and sys-tems science will survive and are quite likely to strengthen in the future. (See also W91-10103) (Fish-PTT)

SOME RECENT ADVANCES IN THE APPLICATION OF THE PRINCIPLE OF MAXIMUM ENTROPY (POME) IN HYDROLOGY, Louisiana State Univ., Baton Rouge. Dept. of Civil

Engineering. For primary bibliographic entry see Field 7C. W91-10136

#### TOWARDS A NEW PARADIGM IN HYDROL-

aster Univ. (England). Dept. of Environmental Sciences.

K. Beven. IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 393-403, 27 ref.

Descriptors: \*Future planning, \*Hydrologic models, \*Hydrology, \*Model studies, \*Research priorities, \*Streamflow forecasting, \*Theoretical analysis, Catchment areas, Heterogeneity, Hydrographs, Prediction, Scale factors, Watersheds.

Hydrological scientists are faced with the problem (common to many of the field sciences) of complexity at small scales leading to relative simplicity (the hydrograph) at large scales. Little or no success has been gained in relating the small to the large scales. Hydrologists will be increasingly forced to think in terms of spatial complexity and spatial pattern but the available tools of analysis are not adequate to accommodate such information. Consequently a theoretical crisis in hydrology. are not adequate to accommodate such informa-tion. Consequently a theoretical crisis in hydrology is imminent. The development of such a crisis was analyzed in terms of the philosophical frameworks of theory change in science. The classical account of the scientific method suggests that theoretical development proceeds by inductive generalization from a body of observations into a formal structure (theory or model) capable of deductive prediction of events, which is further refined by comparison of observations, to improve predictive success. This classical account fails because the principle of induction does not provide a firm basis for theory development due to inconsistencies in logic and development due to inconsistencies in logic and observation dependencies, and because the apdevelopment due to inconsistencies in logic and observation dependencies, and because the ap-proach is rarely broad enough to properly adjust boundary conditions. Some alternatives to this classical account include a falsificationist stance, a theory of paradigm change, and an anarchist view-point. A basis for a new paradigm has been laid in a perceptual model of catchment response, leading to an initial conceptual framework incorporating spatial integration and predictive uncertainty. Hy-drology in the future will require a macroscale droiogy in the tuture will require a macroscate theory that deals explicitly with the problems posed by spatial integration of heterogeneous nonlinear interacting processes (including the effects of preferential flow pathways) to provide a rigorous basis for both 'lumped' and 'physically-based' predictions. (See also W91-10103) (Fish-PTT) W91-10139

#### SOME REFLECTIONS ON THE FUTURE OF HYDROLOGY.

George Washington Univ., Washington, DC. V. Yevjevich, and N. B. Harmancioglu. IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 405-414, 1 fig. U.S. National Science Foundation Grant No. 85-41631.

Descriptors: \*Future planning, \*Hydrology, \*Model studies, \*Research priorities, \*Statistical analysis, Hydrologic data, Hydrologic models, Mathematical models, Physical models, Stochastic hydrology.

Projecting the future of hydrology is a risky task. Future progress will likely result from the utilitarian needs for information on water resources and from the human curiosity to know. As for the other sciences, the cause-effect physical methods and the statistical methods of analysis should be combined in different ways to attain the hydrological research purposes. Future hydrological data, the increase in computational power, progress with hydrological models, and socio-economic complexities, all will force the progress in hydrology in

several specific directions. For physical hydrology, a study of how well the existing basic concepts of hydrology fit the physical reality will lead either to their revision or to new concepts as the basis of progress. For stochastic hydrology, the inquiry of how the astronomic periodicities and the Earth's produced geophysical stochasticity propagate, modify, and mutually interact in the Earth's environments will likely lead to the physical basis and justification for the methods of information extraction from data and for the selection of mathematical models in hydrology. (See also W91-10103) (Author's abstract) W91-10140

#### ADVANCES IN TECHNOLOGY IN HYDROLOGY--A VIEW FROM THE UNITED KINGDOM. For primary bibliographic entry see Field 7B. W91-10147

U.S. GEOLOGICAL SURVEY'S NATIONAL SYSTEM FOR PROCESSING AND DISTRIBUTION OF NEAR REAL-TIME HYDROLOGI-

Geological Survey, Reston, VA. Water Resources For primary bibliographic entry see Field 7C.

W91-10148

# CLIMATE CHANGE AND HYDROLOGICAL RESPONSE IN SOUTHERN AFRICA: HEADING TOWARDS THE FUTURE.

Natal Univ., Pietermaritzburg (South Africa). Dept. of Agricultural Engineering. For primary bibliographic entry see Field 2B. W91-10183

#### LARGE SCALE EFFECTS OF SEASONAL SNOW COVER.

For primary bibliographic entry see Field 2C. W91-10338

# INFLUENCE OF THE VARIABILITY OF SNOW COVER THICKNESS ON THE INTENSITY OF WATER YIELD AND DURATION OF SPRING FLOOD ON A SMALL RIVER.

Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).

(USSR).

B. M. Dobroumov, and A. B. Shukhobodsky.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 253-263, 6 fig. 16 ref.

Descriptors: \*Runoff, \*Runoff forecasting, \*Snow cover, \*Snowmelt, \*Soviet Union, \*Streamflow forecasting, Prediction, Probability, Seasonal distribution, Statistics, Variability coefficient, Water

The main factor influencing prediction of maximum spring runoff from snowmelt is the uneven thickness of the snow cover over the drainage basin area. Investigations carried out over several small plains drainage basins in a forest-steppe zone with a highly dissected surface showed that the use with a highly dissected surface showed that the use of standard values of parameters of the distribution of water equivalent of snow over a basin may result in large errors in determining water yield duration and intensity, and hence the maximum runoff for a year or for a long-term period. For practical applications, it is suggested that statistical relations between the coefficients of variation of the water equivalent of the snow cover and standthe water equivalent of the snow cover and standard meteorological elements such as average snow depth over the basin and mean water equivalent of snow cover be used. It is important to recognize, however, that the coefficient of variation of snow water equivalent in a basin is only a statistical characteristic of the distribution of snow storage over a basin. It does not take into account the actual distribution of snow water equivalent with actual distribution of show water equivalent im-regard to stream channel, slope aspect, landscape, and microforms of relief, which makes the efficien-cy of its use in models considerably lower. One way to overcome this drawback is to use subsets of

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variation coefficients of snow water equivalents for different landscape forms. Where observational data are lacking, practical estimates of the param-eters of the probability curves of water equivalent of the snow cover may be obtained by using the relationships presented here. (See also W91-10338) (Rochester-PTT) W91-10360

WATER AND ENERGY EXCHANGE. National Center for Atmospheric Research, Boul-der, CO.

For primary bibliographic entry see Field 7B. W91-10379

SATELLITE REMOTE SENSING AND FIELD EXPERIMENTS.
Maryland Univ., College Park. Dept. of Meteorol-

For primary bibliographic entry see Field 7B. W91-10382

SYNOPTIC-SCALE HYDROLOGICAL AND BIOGEOCHEMICAL CYCLES IN THE AMAZON RIVER BASIN: A MODELING AND REMOTE SENSING PERSPECTIVE. Washington Univ., Seattle. School of Oceanogra-

phy. For primary bibliographic entry see Field 7B. W91-10385

#### 2B. Precipitation

TIME- AND PH-DEPENDENT LEACHING OF IONS FROM DECIDUOUS AND CONIFEROUS

Geological Survey, Reston, VA. Water Resources

L. J. Puckett.

Canadian Journal of Forest Research CJFRAR, Vol. 20, No. 11, p 1779-1785, 1990. 4 fig, 2 tab, 24

Descriptors: \*Acid rain effects, \*Coniferous for-ests, \*Deciduous forests, \*Forest ecosystems, \*Leaching, \*Vegetation, Calcium ions, Hydrogen ion concentration, Ion exchange, Magnesium ions, Prediction, Sulfates, Temporal variation.

Leaching of ions from foliage of black gum (Nyasa sylvatica Marsh.), chestnut oak (Quercus prinus L.), and white pine (Pinus strobus L.) in response to increasing exposure time to and concentration of hydrogen ions was examined in a laboratory study. Ten individual leaves and needle bundles were exposed to hydrogen ion solutions at pH 3.0, 4.0, and 5.6 for periods of 5, 50, 500, and 1000 minutes. Increases in the removal of Ca(2+) and Mg(2+) from all species tested were strongly related to increases in the experiment duration and hydrogen in concentration confirming the role of ion experiment. ion concentration, confirming the role of ion ex-change in the removal of these ions from the forest canopy. Removal of sodium and potassium ions did not appear to be strongly influenced by ion exchange. Positive relations between SO4(2-) and change. Positive relations between SO4(2-) and hydrogen ions (and presumably chlorine ions) for the deciduous species suggest that anion exchange may be involved in the removal process. Given the relatively small number of anion exchange sites on cuticles, and because SO4(2-) is the primary anion in both rain and throughfall, anion exchange is not likely to contribute significant amounts of anions under natural conditions. Extrapolation of results from an experiment of this type to what might be expected under natural conditions is difficult. However, the response of whole leaves and needles fits that expected based on the ion selectivity dles fits that expected based on the ion selectivity of the cuticle as a carboxylic acid ion-exchange medium, and holds promise for understanding the processes involved in ion leaching from forest canopies. (Author's abstract) W91-09362

TRACE ELEMENTS IN THE NORTH ATLANTIC TROPOSPHERE: SHIPBOARD RESULTS OF PRECIPITATION AND AEROSOLS.
Delaware Univ., Newark. Coll. of Marine Studies.

T. M. Church, A. Veron, C. C. Patterson, D.

Settle, and Y. Erel.
Global Biogeochemical Cycles GBCYEP, Vol. 4, No. 4, p 431-443, December 1990. 5 fig, 4 tab, 53

Descriptors: \*Aerosols, \*Air masses, \*Air pollution, \*Fog, \*Geochemistry, \*North Atlantic Ocean, \*Pacific Ocean, \*Path of pollutants, \*Precipitation, \*Trace elements, \*Troposphere, Cadmium, Field tests, Heavy metals, Lead, Meteorological data, Mixing, Pollutant identification, Precipitation, \*Precipitation, \*Precipit tion scavenging, Rainfall, Snow

Samples for trace metals in precipitation (rain, snow, and fog) and total aerosols were collected at sea as part of the GCE/CASE/WATOX expedition during August and September 1988 in the greater North Atlantic between Bermuda, Iceland, the Azores, and Barbados. The samples were collected, using ultra-clean equipment and methods, for the analysis of the trace elements Al, Fe, Mn, Zn, Cu, Ni, Cd, and Pb (including stable isotopes). The samples were analyzed by graphite furnace atomic absorption spectrometry and thermal ionization mass spectrometry. Four air masses were delineated including: (I) temperate US; (2) boreal Canadian westerlies, and (3) boreal and northern Europe easterlies associated with (4) Mediterranean and Saharan easterlies. The contrasting ratios between precipitation and aerosol demonstrate a vertical mixing of chemical sources in precipitation vertical mixing of chemical sources in prespiration from contrasting air masses of different origin. Scavenging ratios were calculated for lead and cadmium during select periods when aerosol and precipitation were collected under the same meteorological regimes. The cadmium ratio is much greater than that of lead, indicating that cadmium recommendations are successively assessed to the cadmium recommendation. and lead are each transported or scavenged on distinct populations of aerosols. For lead, the ratio is less in the North Atlantic than in the Pacific, suggesting an aerosol concentration dependence. Like the Pacific, the ratios increase for the lead, dust and sea salt. The marine scavenging ratios cannot yet be used effectively until factors such as concentration dependency and local conditions of tropospheric processing are better defined. (Brun-one-PTT) one-PTT) W91-09380

DISSOLVED, PARTICULATE AND ACID-LEACHABLE TRACE METAL CONCENTRA-TIONS IN NORTH ATLANTIC PRECIPITA-TION COLLECTED ON THE GLOBAL CHANGE EXPEDITION,
University of Feet

University of East Anglia, Norwich (England). School of Environmental Sciences.

B. Lim, and T. D. Jickells.
Global Biogeochemical Cycles GBCYEP, Vol. 4, No. 4, p 445-458, December 1990. 2 fig, 12 tab, 57

Descriptors: \*Air pollution, \*Atmospheric chemistry, \*Dissolved solids, \*Geochemistry, \*Leaching, \*North Atlantic Ocean, \*Particulate matter, \*Path of pollutants, \*Precipitation, \*Trace metals, Acid rain, Acidification, Aluminum, Cadmium, Chemistry of precipitation, Copper, Heavy metals, Iron, Lead, Manganese, Ocean circulation, Solubility, Surface water, Trace elements, Zinc.

Atmospheric inputs of trace metals into surface waters are an important pathway for the oceanic biogeochemical cycling of many trace constituents. Rainwater samples from six precipitation events Rainwater samples from six precipitation events were collected on board ship during legs 3 and 4 of the Global Change Expedition over the North Atlantic Ocean and analyzed for dissolved, particulate (Al and Pb), and acid-leachable trace metals (Al, Fe, Mn, Cd, Cu, Pb, Zn). Acid-leachable concentrations of the elements (in 0.4% v/v HNO3) were similar to reported values from the North Atlantic and Pacific Oceans which were measured using comparable acidification procedures. Concentrations of dissolved and particulate Al and Pb were determined in rain events concurdures. Concentrations of dissolved and particulate Al and Pb were determined in rain events concurrently sampled. Comparisons between acid-leachable and total (dissolved plus particulate) trace metal concentrations suggest that the acid-leachable fraction of metals can significantly underestimate total concentrations of crustal elements in rain. The solubilities of Al and Pb in precipitation

were variable and mean solubilities of the elements were 13% and 45%, respectively. Recycled sea salt components were less than 14% for Al, Fe, Mn, Pb, Cd, Cu, and Zn, indicating that the net trace metal flux is from the atmosphere to the oceans. Deep sea particle fluxes for these metals through the western tropical North Atlantic exceed atmospheric deposition fluxes by a factor of 18 to 41. (Author's abstract) W91-09381

ERROR STRUCTURE OF MULTIPARAMETER RADAR AND SURFACE MEASUREMENTS OF RAINFALL, PART I: DIFFERENTIAL REFLEC-TIVITY

Colorado State Univ., Fort Collins. Dept. of Electrical Engineering.
For primary bibliographic entry see Field 7C.

ERROR STRUCTURE OF MULTIPARAMETER RADAR AND SURFACE MEASUREMENTS OF RAINFALL, PART II: X-BAND ATTENU-ATION

Colorado State Univ., Fort Collins. Dept. of Electrical Engineering.
For primary bibliographic entry see Field 7C. W91-09383

EXTERNAL QUALITY-ASSURANCE RESULTS FOR THE NATIONAL ATMOSPHERIC DEPO-SITION PROGRAM/NATIONAL TRENDS NETWORK DURING 1988.

Geological Survey, Denver, CO. Water Resources

For primary bibliographic entry see Field 7B. W91-09527

CLIMATIC VARIABILITY AND FLOOD FRE-QUENCY OF THE SANTA CRUZ RIVER, PIMA COUNTY ARIZONA.

Geological Survey, Tucson, AZ. Water Resources

For primary bibliographic entry see Field 2E.

STIMULATION OF PHYTOPLANKTON PRO-DUCTION IN COASTAL WATERS BY NATURAL RAINFALL INPUTS: NUTRITIONAL AND TROPHIC IMPLICATIONS.

North Carolina Univ. at Chapel Hill. Inst. of e Science

Marine Sciences.

H. W. Paerl, J. Rudek, and M. A. Mallin.

Marine Biology MBIOAJ, Vol. 107, No. 2, p 247-254, 1990. 6 fig. 1 tab,48 ref. National Science Foundation OCE 88-20036; BSR 89-18482, North Carolina Sea Grant RMER-10 and the U.S.E.P.A. State of North Carolina Albemarle Pamlico Estuation State (VS 814870 6). rine Study CX-814570-01-0.

Descriptors: \*Acid rain, \*Aquatic productivity, \*Bioassay, \*Chemistry of precipitation, \*Eutrophication, \*Nitrogen cycle, \*Phytoplankton, Nitrogen compounds, Nutrients, Precipitation, Trophic level.

Increased coastal and estuarine eutrophication has prompted the consideration of atmospheric nutriprompted the consideration of almospheric nutri-ent loading in the formulation of current manage-ment strategies. The potential impact on phyto-plankton production of atmospheric nitrogen load-ing (ANL), as local rainfall, in representative shal-low, nitrogen limited North Carolina mesohaline estuarine and euhaline coastal Atlantic Ocean habitats was examined. In situ bioassays showed that tats was examined. In situ bioassays showed that rainfall at naturally occurring dilutions (0.5 to 5%) significantly stimulated both 14CO2 assimilation and chlorophyll a production, both indicators used to monitor natural plankton growth response. Nitrogen was identified as the growth stimulating nutrient source. More acidic rainfall led to greater growth stimulation, especially at lower dilutions. Also, an inverse relationship between pH and NO3(-) content was observed. Consideration of atmospheric nutrients is of vital importance in proatmospheric nutrients is of vital importance in protocols designed to mitigate coastal eutrophication. (D'Agostino-PTT)

W91-09680

CLASS—A CANADIAN LAND SURFACE SCHEME FOR GCMS: I. SOIL MODEL.
Canadian Climate Centre, Downsview (Ontario). For primary bibliographic entry see Field 2A.
W91-09701

EFFECT OF DOMAIN SHAPE ON PRINCIPAL COMPONENTS ANALYSES.
Oklahoma Univ., Norman. Dept. of Geography. For primary bibliographic entry see Field 7C. W91-09702

MARINE STRATOCUMULUS CLIMATOLO-GIES.

Cooperative Inst. for Research in Environmental Science, Boulder, CO.

H. P. Hanson. H. P. Hanson.
International Journal of Climatology IJCLEU,
Vol. 11, No. 2, p 147-164, March 1991. 12 fig, 43
ref. U.S. National Aeronautics and Space Administration, Langley Research Center, Grant No.
NAG-1-651; U.S. Office of Naval Research,
Marine Meteorology Program, Grant No. N0001424.4446

Descriptors: \*Atmospheric circulation, \*Climatology, \*Cloud cover, \*Clouds, \*Marine climates, \*Stratocumulus clouds, Temperature effects, Water temperature, Weather patterns.

Conditions favorable to the formation and maintenance of marine stratocumulus cloud decks commonly occur in the subtropical latitudes off the west coasts of the major continents. The cloud decks over the eastern North and South Pacific and the eastern South Atlantic are well-established examples of the phenomenon; the eastern North Atlantic exhibits rather different behavior. Largescale climatological averages based on data ex-tracted from the Comprehensive Ocean-Atmosphere Data Set are remarkably similar in the three of these regions that exhibit well-established marine stratocumulus cloud decks. Off the coast of northwest Africa, however, the sea-surface temperatures (SSTs) are higher and the cloud cover is less overgast than for the other season. peratures (SS1s) are higher and the cloud cover is less overcast than for the other regions. The corre-lation between interannual changes in clouds and SST is negative in all four areas: years with lower than normal SST tend to be more cloudy. The implication of this for climate system feedbacks is that these clouds have the protential to evert socithat these clouds have the potential to exert posi-tive feedback in the climate system. A zero-order estimate of the strength of this positive feedback suggests that it could be comparable to that due to water vapor in the atmosphere. (Author's abstract) W91-09703

INDIAN SUMMER MONSOON RAINFALL AND 200-MBAR MERIDIONAL WIND INDEX: APPLICATION FOR LONG-RANGE PREDIC-TION.

B. Parthasarathy, K. R. Kumar, and V. R. Deshpande.

International Journal of Climatology IJCLEU, Vol. 11, No. 2, p 165-176, March 1991. 5 fig, 3 tab,

Descriptors: \*Atmospheric circulation, \*Climatology, \*India, \*Monsoons, \*Rainfall forecasting, \*Weather forecasting, Correlation analysis, Regression analysis, Seasonal variation, Weather patterns, Wind.

Because of the large year-to-year variability of the summer monsoon rainfall over India, seasonal forecasting has assumed one of the most important aspects of the summer monsoon rainfall. The longrange forecast of monsoon rainfall involves statisti-cal and synoptic methods together with qualitative reasoning, mainly on the basis of a correlation approach. An association has previously been identified between Indian monsoon rainfall and 200-mbar meridional wind index for the month of May, indicating the possibility of its potential for predic-tion of the seasonal rainfall. A detailed investiga-tion has been made of this relationship between the

monsoon rainfall over India and the meridional wind index (arithmetic average of 200-mbar merid-ional wind component for May at Bombay, Delhi, Madras, Nagpur, and Srinagar) based on the data for the period 1964-1988. The relationship between all-India monsoon (June-September) rainfall (R) and the wind index (Vm) is negative (correlation coefficient = -0.72) and is significant at the 0.1% level and the regression equation based on this data, for the period 1964-1988, is R = 86.98-2.44 Vm. The stability and consistency of the relationship between rainfall and the wind index have been examined over sliding widths of 15 and 21 years, and the relationship is found to be significant at the and the relationship is found to be significant at the 1% level for all windows of 21-year widths. The meridional wind index shows a good potential in the long-range prediction scheme of the Indian monsoon rainfall, along with other patterns. (Author's abstract)

RAINFALL ANOMALY PATTERNS IN DRY AND WET YEARS OVER NIGERIA, Ilorin Univ. (Nigeria). Dept. of Geography.

O. J. Olaniran.

International Journal of Climatology IJCLEU,
Vol. 11, No. 2, p 177-204, March 1991. 18 fig, 26

Descriptors: \*Climatic data, \*Climatology, \*Nigeria, \*Rainfall, \*Rainfall distribution, \*Weather pat-terns, Areal precipitation, Rainfall area, Rainfall rate, Spatial distribution, Tropic zone, Tropical

Some researchers interested in the description of climatic anomalies or the understanding of their causal mechanisms have analyzed climatic data causal mechanisms have analyzed climatic data separately for dry and wet years in relation to the long-term mean conditions. Rainfall amount and rainfall frequency for five individual dry and five individual wet years were compared with the 1941-1987 averages for Nigeria. Five spatial-anomaly types were found to emerge for dry years, namely above-average rainfall in southern Nigeria but below-average rainfall in northern Nigeria (spatial type I), above-average rainfall in the coastal and extreme northern parts of the country (spatial type treme northern parts of the country (spatial type II), and below-average rainfall in southern Nigeria II), and below-average rainfall in southern Nigeria but above-average rainfall in northern Nigeria (spatial type III). The other two anomaly types are country-wide occurrence of below-average rainfall (spatial type IV) and above-average rainfall (spatial type V). These spatial-anomaly types also hold true for wet years, except that the spatial type II is replaced by the occurrence of below-average rainfall in fall in the center but above-average rainfall in the coastal and extreme northern parts of the country. coastal and extreme northern parts of the country (spatial type VI). The spatial type I and II anomalies support the hypothesis of a restricted northward advance of the Inter Tropical Discontinuity nes support the hypothesis of a restricted north-ward advance of the Inter Tropical Discontinuity (ITD) in dry years and on a complementary basis the spatial patterns for the rainfall amount anomaly (RAA) and the rainfall frequency anomaly (RFA) depicted these two anomaly types in 40% of the monthly periods for the set of dry years considered. The spatial type IV anomaly, which occurs during the peak of the rainy season, supports the hypothesis of a weakening of the rainy season intensity and on a complementary basis the spatial patterns for the RAA and the RFA depicted this pattern in 30% of the monthly periods for the dry years studied. This shows that both hypotheses are valid for explaining dry years in subtropical West Africa. The spatial type III and V anomalies support the hypothesis of a considerable northward incursion of the ITD in wet years. It was found that the spatial patterns of the RAA depicted these anomaly types in 53.3% of the monthly periods while the spatial patterns of the RFA depicted the anomaly types in 65.7% of the monthly periods for the set of wet years considered. (Author's abstract) W91-09705

QUANTITATIVE RELATIONSHIPS OF MEAN SEASONAL PRECIPITATION IN THE TAGUS RIVER BASIN (SPAIN).

RIVER BASIN (SPAIN).

Salamanca Univ. (Spain). Dept. of Air Physics.

A. Egido, M. Egido, J. Seco, and J. Garmendia.

International Journal of Climatology IJCLEU,

Vol. 11, No. 2, p 205-212, March 1991. 4 fig, 2 tab,

Descriptors: \*Climatology, \*Rainfall distribution, \*Seasonal distribution, \*Spain, Altitude, Areal precipitation, Atmospheric circulation, Climatic data, Climatic zones, Mountains, Topography, Wind.

Precipitation has been one of the meteorological components to which considerable attention has been paid in recent years since knowledge of its temporal and spatial distribution is essential for later application in terms of the exploitation of water resources. Such research can therefore be considered to lie within the bounds of applied climatology. Following the line of research being carried out in recent years on precipitation distribution for large, climatically homogeneous zones of the Iberian Peninsula, further study was made to complete the work for the Tagus basin (Spain), Pluviometric distribution was analyzed for the four different astronomical seasons: winter (December-February), spring (March-May), summer (June-August), and autumn (September-November). The relationships were determined between each of the geoclimatic factors-altitude, Laplacian of the altitude, distance from mountain range, and distance from the west coest-unith precipitation. It was tude, distance from mountain range, and distance from the west coast-with precipitation. It was found that precipitation increases with altitude, the highest values corresponding to the winter period and the lowest to summer. The effect of anomalies in the terrain leads to increases in precipitation which are more pronounced in winter than in the other seasons. The influence of distance from the mountain range causes decreases in precipitation from the Central System towards the southern ntain range. Precipitation maxima are seen in mountain range. Precipitation maxima are seen in winter, spring, and autumn, possibly due to the inertia shown by the cyclonic air stream with a northerly component on ascending the windward side of the Central System. Decreases are seen in precipitation in winter, spring, and autumn as the distance from the west coast increases and one proceeds towards the interior of the peninsula. Such decreases are greater in winter and smaller in spring and autumn. By contrast, in summer a slight but not very significant increase in precipitation is but not very significant increase in precipitation is observed as the distance from the west coast increases. (Fish-PTT) W91-09706

CLIMATOLOGICAL PATTERNS OF THUN-DERSTORM ACTIVITY IN SOUTH-EASTERN

Indiana Univ. at Bloomington. Dept. of Geography.

D. R. Easterling.
D. R. Easterling.
International Journal of Climatology IJCLEU,
Vol. 11, No. 2, p 213-221, March 1991. 3 fig, 1 tab,

Descriptors: \*Climatic data, \*Climatology, \*Global warming, \*Principal component analysis, \*Statistical methods, \*Thunderstorms, \*Weather patterns, Atmospheric circulation, Climatic changes, Meteorological data, Rainfall distribution, Spatial distribution.

The current concern over global climate change, and in particular its regional effects, has illustrated the need to document and understand existing patterns of climate. Climatological patterns of summertime thunderstorm activity were examined for most of the southeastern U.S., excluding the Florian activity. Mosthly, anyther of thunderstorm a peninsula. Monthly numbers of thunderstorm observations at 61 stations for the period 1951-1977 were analyzed by means of principal components analysis. (PCA) to identify recurring spatial patanalysis (PCA) to identity recurring spatial pat-terns. The first seven components were found to contain nonrandom patterns and were subjected to an oblique rotation. The results indicate that there are approximately six distinct spatial patterns. A high correlation between two of the rotated com-ponents (RCs) and the similarity of their spatial loading patterns implies that they may be manifes-tations of the same pattern. Months with the high-est component scores for each of the first four est component scores for each of the first four components were used as pattern examples to ex-amine their upper level circulation. Maps of the percentage of the monthly average for each month showed reasonably good correspondence between

#### Field 2—WATER CYCLE

#### **Group 2B—Precipitation**

the rotated component pattern centers and the areas of maximum thunderstorm occurrence. Synareas of maximum thunderstorm occurrence. Synoptic-scale climatological patterns are evident in thunderstorm activity over the southeastern U.S.; each part of the region loads highly (>0.60) on at least one RC, suggesting that the loading patterns and associated circulation patterns are the dominant patterns of summertime thunderstorm activity in the southeast. The RC loading patterns could prove useful in developing climate analogs for use in climate-impact research. (Fish-PTT) W91-09707

MODELING DAILY RAINFALL USING A SEMI-MARKOV REPRESENTATION OF CIRCULATION PATTERN OCCURRENCE.

Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydrologie und Wasserwirtschaft.

A. Bardossy, and E. J. Plate.
Journal of Hydrology JHYDA7, Vol. 122, p 33-47,
January 1991. 6 fig, 2 tab, 23 ref.

Descriptors: \*Atmospheric circulation, process, Meteorology, Model studies, Precipita-tion, \*Time series analysis, \*Weather patterns, Cli-matic changes, Mathematical studies, Probable maximum precipitation.

The daily rainfall occurrence process is modeled as a process coupled to atmospheric circulation. At-mospheric circulations are classified into a finite number of circulation patterns. Time series of circulation patterns are modeled with the help of a semi-Markov field. Rainfall is linked to the circulation patterns using conditional probabilities. The model is applied using the classification scheme of the German Weather Service for the time period 1881-1988. Precipitation data measured at different locations for a period of 34 years are linked to the circulation patterns. Using the model several series of circulation patterns and corresponding rainfall occurrences are simulated. It was concluded that rainfall occurrences are strongly linked to the at-mospheric circulation and can be modeled as a coupled process. Atmospheric circulations are classified into a finite number of circulation patclassified into a finite number of circulation patterns. Rainfall occurrences are linked to the circulation patterns with the help of conditional probabilities. The coupled model can be used for the simulation of stationary and non-stationary rainfall time-series using a corresponding model for the atmospheric circulations. Thus it can be a useful tool for climate change modeling. The results of the simulation based on the model without any optimization of the model parameters reproduce important statistics of the observed series. (Agose-PTT)

EVALUATION OF PROCEDURES TO ESTI-MATE MONTHLY PRECIPITATION PROB-

Oklahoma Univ., Norman. Dept. of Geography. Journal of Hydrology JHYDA7, Vol. 122, p 129-140, January 1991. 2 fig, 1 tab, 35 ref.

Descriptors: \*Climatology, \*Mathematical studies, \*Meteorology, \*Precipitation, \*Probable maximum precipitation, \*Time series analysis, Frequency distribution. Model studies

Many frequency distributions have been used to evaluate monthly precipitation probabilities. Eight of these distributions (including Pearson type III, extreme value, and transform-normal probability functions) were comparatively examined to deter-mine their ability to accurately represent variations in monthly precipitation totals for global hydrocliin monthly precipitation totals for global hydrocinatological analyses. Cross-validation was used to evaluate the efficacy of each probability density function (PDF). One hundred years of monthly precipitation totals (1870-1985) were obtained for 253 stations (3036 evaluation months). However, only those months for which at least 80% of the observations were non-zero could be evaluated. This reduced the total number of months to 2759. A random sample of 50 years (without replace-ment) was selected for each evaluation month and was used to compute the parameters for each dis-tribution. The Kolmogorov-Smirnov test was then

used with the remaining time-series to evaluate each PDF. Results indicated that the modified Box-Cox transform-normal PDF was the best PDF BOX-LOX transform-normal PDF was the best PDF for evaluating monthly precipitation totals across a wide range of climate types. Some of the more frequently used distributions, (e.g. the Gumbel, gamma, and logarithmic-transform PDF) were not able to represent consistently the observed distributions and three failed for > 30% of the evaluations and three failed for > 30% of the evaluations. outnots and tirree failed for > 30% of the evalua-tion months at 95% confidence level. This fact underscores the importance of quantitatively eval-uating the chosen PDF for any application. (Agos-tine-PTT) W91-09740

DETERMINATION IN REAL TIME OF THE RELIABILITY OF RADAR RAINFALL FORE-CASTS. Ecole Nationale des Ponts et Chaussees, Paris

France). T. Einfalt, and G. Jacquet.
T. Denoeux, T. Einfalt, and G. Jacquet.
Journal of Hydrology JHYDA7, Vol. 122, p 353371, January 1991. 5 fig. 6 tab. 44 ref. French
Ministry of Construction Plan Urbain Contract 8431395-00-223-75-01.

Descriptors: \*Precipitation, \*Radar, \*Rainfall, \*Weather forecasting, Atmosphere, Drainage systems, France, Hydrology, Mathematical studies, Prediction, Statistical analysis.

Quantitative rainfall forecasts obtained from inter-Quantitative rainfall forecasts obtained from inter-pretation of radar data can be of great interest in urban hydrology, provided their reliability is known in real time. The feasibility of an a priori estimation of forecast reliability from characteris-tics of rainfall areas and atmospheric vertical struc-ture is examined. The first step has been to design a method to check the relevance of a criterion of forecasting audity to a particular application of forecasting quality to a particular application of the forecasts. This method was applied to the case of real time control of a drainage network in a suburban area of Paris, and led to the definition of a new quality criterion, consistent with the user's a new quanty criterion, consistent with the user's utility function. Potential predictors of forecasting quality were then defined, to be calculated in real time from radar and rawinsonde data. In the final step, statistical and heuristic techniques, applied to a learning set of examples taken from 46 rainfall events, provided decision rules which can be used in real time to estimate the quality of radar fore-casts. Although these rules are valid only in a specific operational context, the methodology is general, and can be transferred to other forecasting problems in hydrology, as well as in other do-mains. (Author's abstract)

REGIONAL HYDROLOGICAL EFFECTS OF CLIMATE CHANGE.

National Technical Univ., Athens (Greece). Div. of Water Resources. For primary bibliographic entry see Field 2A. W91-09785

PARAMETERIZATION OF THE CONDENSA-TION PROCESS: A THEORETICAL AP-TION PE PROACH.

Centre National de Recherches Meteorologiques, Toulouse (France).

Journal of the Atmospheric Sciences JAHSAK, Vol. 48, No. 2, p 264-282, January 15, 1991. 11 fig, 25 ref, append.

Descriptors: \*Cloud liquid water, \*Condensation, \*Dew, \*Fluid drops, \*Meteorology, Atmospheric circulation, Clouds, Nucleation, Supersaturation,

A complete description of the condensation process must include representations of both the nucleus and the droplet distributions. A theoretical formulation has been developed that allows separate consideration of the major factors governing cloud droplet spectra in nonprecipitating cumulus clouds: activation of nuclei, condensational growth, and turbulent mixing. Broad spectra are treated as combinations of elementary droplet populations, each of which is characterized by its spectrum of acti-

vated nuclei and its degree of condensational growth. The broadening of the spectra is described in terms of density functions of each of these two terms. The method was applied to one-dimensional schemes to understand better the effects of basic hypotheses on the vertical evolution of the drop-let-size distribution and the possible occurrence of superadiabatic growth. Fluctuations of cloud base altitude or of droplet concentration can be at least as significant as entrainment for broadening the adiabatic spectra. Variations in the maximum supersaturation within activation regions result in variations of the initial spectrum. This is a crucial reature of the development of droplet spectra in clouds which has been poorly documented before. The parameterization of nucleation in the representation of the degree of condensational growth and its inclusion in an Eulerian frame was briefly examined. This method applied in multidimensi ulations, and used for the interpretation of observa-tions at high resolution will hopefully lead to im-provements in knowledge of the condensation process. (Fish-PTT) W91-09788

EVOLUTION OF RAINDROP SPECTRA: PART III. DOWNDRAFT GENERATION IN AN AXI-SYMMETRICAL RAINSHAFT MODEL.

Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences

G. Feingold, Z. Levin, and S. Tzivion. Journal of the Atmospheric Sciences JAHSAK, Vol. 48, No. 2, p 315-330, January 15, 1991. 13 fig, 41 ref, append.

Descriptors: \*Atmospheric circulation, \*Fluid drops, \*Meteorology, \*Model studies, \*Rain, \*Simulated rainfall, Aerosols, Air temperature, Clouds, Mass spectra, Precipitation, Rainfall disposition. Weather

The size distribution of raindrops is important in a wide range of fields: radar measurements of rainfall, the scavenging of aerosol particles below cloud base, subcloud evaporation, the generation of intense downdrafts, and others. Studies of these problems necessitate good spatial and temporal resolution of the drop spectrum in the volume of air below cloud base. The evolution of raindrop spectra below cloud base in subsaturated atmospheres was traced with the aid of an axisymmetrical rainshaft model which includes the detailed cal rainshaft model which includes the detailed warm microphysical treatment presented in parts I and II of this series. As input to the model, a stationary cloud provides rainfall with a predetermined drop spectrum. Mass loading and evapora-tive cooling generate downdrafts below cloud base. For near-adiabatic lapse rates and moderate mass loading, microbursts develop. For a given liquid water content, the magnitude of these down-drafts depends primarily on the lapse rate of temperature, but also on the drop spectrum injected at cloud base. For a given liquid water content, spec-tra comprising a relatively large number of small drops tend to generate significantly stronger downdrafts than spectra with a greater component of large drops. Drop collection and breakup may also large drops. Drop collection and breakup may also affect the magnitude of the generated downdrafts significantly. When spectra comprising mainly small drops, evolve to create larger drops, or when spectra comprising mainly large drops evolve to create smaller drops, neglect of collection and breakup can modify the downdrafts by up to about 50%. In a steady state situation the drop spectra evolve toward bimodal or trimodal spectra as predicted by simple rainshaft models with fixed dynamics. (See also W90-04597) (Author's abstract) W91-09789

MESO-BETA SCALE POTENTIAL VORTICITY ANOMALIES AND RAINBANDS: PART II. MOIST MODEL SIMULATIONS.

Toronto Univ. (Ontario). Dept. of Physics.

H. R. Cho, and D. Chan.

Journal of the Atmospheric Sciences JAHSAK, Vol. 48, No. 2, p 331-341, January 15, 1991. 9 fig, 9

Descriptors: \*Cyclones, \*Meteorology, \*Model studies, \*Precipitation, \*Rainfall, \*Simulation anal-

ysis, \*Storms, \*Vortices, Atmospheric circulation, Clouds, Latent heat, Rainfall distribution, Simulated rainfall, Water vapor, Weather.

In a prior study, it was suggested that mesoscale potential vorticity anomalies are a possible cause for the formation of rainbands. A two-dimensional semigeostrophic frontogenesis model was used to study meso-beta scale potential vorticity anomalies as a possible cause for rainbands in midlatitude cyclones. The model includes water vapor and allows the formation of stratiform clouds. Simulation results indicate that height-dependent potential vorticity anomalies are effective mechanisms causing the formation of rainbands. The shape and intensities of the rainbands depend sensitively on the structure of the initial anomalies, and the initial distribution of moisture. Model results show that latent heat released in rainbands induces significant perturbations in the potential temperature and potential vorticity fields that affect the subsequent evolution of the rainbands. These heating induced anomalies may be a substantial source of inhomogeneities at the meso-beta scale in the potential vorticity field of the atmosphere. (Fish-PTT)

RETRIEVAL OF MONTHLY RAINFALL INDI-CES FROM MICROWAVE RADIOMETRIC MEASUREMENTS USING PROBABILITY DIS-TRIBITION FUNCTIONS.

NATION FUNCTIONS, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. T. T. Witheit, A. T. C. Chang, and L. S. Chiu. Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 8, No. 1, p 118-136, February 1991. 9 fig, 8 tab, 26 ref, 2 append.

Descriptors: \*Climatic data, \*Meteorological data collection, \*Meteorology, \*Radiometry, \*Rainfall, \*Remote sensing, Algorithms, Instrumentation, Microwaves, Probability distribution, Probable maximum precipitation, Radar, Rainfall intensity.

Rainfall both influences and is influenced by the dynamics of the earth's atmosphere. An approach has been developed to estimate the rainfall integrated over time and space scales of climatological interest using operationally available microwave radiometric data. An algorithm for the estimation of monthly rain totals for 5-degree cells over the oceans was derived from histograms of special sensor microwave imager (SSM/I) brightness temperatures. There are three novel features to this algorithm. First, it uses knowledge of the form of the rainfall intensity probability density function to augment the measurements. Second, a linear combination of the 19.35 and 22.235 GHz channels has been employed to reduce the impact of variability of water vapor. Third, an objective technique has been developed to estimate the rain layer thickness from the 19.35 and 22.235-GHz brightness temperature histograms. Comparison with climatologies and the GATE radar observations suggest that the estimates are reasonable in spite of not having a beam-filling correction. By-products of the retrievals indicate that the SSM/I instrument noise level and calibration stability are quite good. (Author's abstract)

GROUND-BASED MEASUREMENTS OF RAINDROP FALLSPEEDS.

Auckland Univ. (New Zealand). Dept. of Physics. J. G. Hosking, and C. D. Stow. Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 8, No. 1, p 137-147, February 1991. 9 fig. 23 ref.

Descriptors: \*Fall velocity, \*Fluid drops, \*Instrumentation, \*Rain, Atmospheric circulation, Laboratory equipment, Numerical analysis, Simulation analysis.

A knowledge of raindrop fallspeeds is important, for example in modeling precipitation growth and scavenging, and in estimating drop size from areal detectors and Doppler radar. However, in the past there have been very few measurements of the fallspeeds of natural raindrops with which to compare laboratory measurements. Therefore, typical

results of field measurements of the fallspeeds of natural raindrops have been analyzed and instrumental effects investigated by numerically simulating the measurement processes. Deviations between the measured fallspeeds and those expected on the basis of theory and windtunnel results were found to be smaller than those found by previous investigators, probably because of the improved instrumentation used. This was particularly obvious for drops smaller than about 0.5 mm radius. The random component of these deviations was consistent with estimated experimental error, but on average drops were found to fall about 5-10% slower than expected, and this mean deviation increased with drop size; these data are consistent with the existence of local updrafts and downdrafts. The effects of the observed fallspeed fluctuations on estimates of other quantities at ground level (e.g. drop radius) were considered to be significant. (Fish-PTT)

DETERMINATION OF PRECIPITATION PRO-FILES FROM AIRBORNE PASSIVE MICRO-WAVE RADIOMETRIC MEASUREMENTS.

National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences. C. Kummerow, I. M. Hakkarinen, H. F. Pierce, and J. A. Weinman.

JAOTES, Vol. 8, No. 1, p 148-158, February 1991. 6 fig, 1 tab, 19 ref.

Descriptors: \*Instrumentation, \*Meteorological data collection, \*Microwaves, \*Radiometry, \*Rainfall distribution, \*Rainfall rates ensing, Atmospheric circulation, Climatic data, Clouds, Data storage and retrieval, Hydrometeorology, Model studies, Radar, Regression analysis, Thunderstorms.

The global distributions of rainfall near the surface have been derived from satellite observations made at visible, infrared, and microwave frequencies, but this information cannot address the problem of latent heating distributions as these are known to vary greatly for different types of clouds. A study was done of the first quantitative retrievals of vertical profiles of precipitation derived from multispectral passive microwave radiometry. Measurements of microwave brightness temperature (Tb) obtained by a NASA high-altitude research aircraft were related to profiles of rainfall rate through a multichannel piecewise-linear statistical regression procedure. Statistics for Tb were obtained from a set of cloud radiative models representing a wide variety of convective, stratiform, and anvil structures. The retrieval scheme itself determines which cloud model best fits the observed meteorological conditions. Retrieved rainfall rate profiles were converted to equivalent radar reflectivities from a ground-based research radar. Results for two case studies, a stratiform rain situation and an intense convective thunderstorm, show that the radiometrically derived profiles capture the major features of the observed vertical structure of hydrometeor density. (Author's abstract)

#### COMPLETE POLARIMETRIC AND DOPPLER MEASUREMENTS WITH A SINGLE RECEIV-ER RADAR.

National Severe Storms Lab., Norman, OK.

Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 8, No. 1, p 159-165, February 1991. 2 fig, 22 ref.

Descriptors: \*Data transmission, \*Hydrometeorology, \*Meteorological data collection, \*Meteorology, \*Radar, \*Rain, \*Remote sensing, \*Satellite technology, Data storage and retrieval, Meteorological data, Polarization, Precipitation, Weather data collections.

Polarimetric measurements have been an active area of research in the U.S. and abroad over the last decade. Polarimetric scattering matrix concepts are applicable to hydrometeors to indicate the total number of measurands possible from a

radar system with two orthogonal linear polarizations. An analysis has been made of how to obtain this complete set of polarimetric measurands together with Doppler spectral moments through a single receiver by proper choice of polarization in a transmit-receive sequence pair. Fundamental to the proposed scheme is a trade-off between parallel processing (requiring two receivers) and sequential processing with one receiver. This trade-off is possible because weather echoes are statistically stationary and highly correlated. Thus, the value of the correlations at zero lag as well as the mean Doppler shift can be estimated even though the measurements are not made simultaneously. In general, differential phase shifts that may be estimated are composites of propagation and scattering phase shifts. At a 10-cm wavelength, phase shifts due to scattering are negligible (except in large hail or large wet snowflakes) and, therefore, the dominant phase term in the equations is from differential propagation. Thus, simple-to-compute procedures requiring storage of conjugate products can yield all the polarimetric and Doppler parameters simultaneously if sequence-specific switching of the polarization-on-reception is employed. It is possible to derive well-known parameters such as the reflectivity factors, differential propagation constant, and the correlation coefficient between copolar received echoes. Two lesser-known correlations between orthogonal echoes are also available, but their interpretation in the context of the ensemble of scattering hydrometeors needs to be explored. (Fish-PTT)

USE OF ROTATING PINHOLES AND RETI-CLES FOR CALIBRATION OF CLOUD DROP-LET INSTRUMENTATION.

Sverdrup Technology, Inc., Cleveland, OH. For primary bibliographic entry see Field 7B. W91-09804

# CLIMATE AND STREAMFLOW VARIABILITY RELATED TO WATER SUPPLY IN THE WESTERN UNITED STATES,

Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
D. Changnon, T. B. McKee, and N. J. Doesken.

D. Changnon, T. B. McKee, and N. J. Doesken. Available from National Technical Information Service, Springfield, VA 22161 as PB91-143115/ AS. Price codes: A07 in paper copy, A01 in microfiche. Final Report, August 1990. 141p, 60 fig. 16 tab, 78 ref. 5 append. USGS Contract No. 14-08-0001-G1294.

Descriptors: \*Climates, \*Rocky Mountain region, \*Snowpack, \*Streamflow, \*Variability, \*Water supply, \*Weather patterns, Climatic data, Data analysis, Distribution patterns.

Interrelated hydroclimatic elements were investigated to determine characteristics of the spatial and temporal climate variability in a five-state region in the Northern Rocky Mountains, covering the 1951-1985 period. The three primary hydroclimatic elements analyzed included total water-year streamflow (ST), winter (October 1-March 31) accumulated precipitation (PR), and April 1 snow-pack (SN). Analysis of SN and PR data sets, from about 270 sites across the five-state study area, revealed that the 0.55 measure of variability isoline separated stable regions from unstable regions. Nearly a factor of two difference was observed in the average magnitude of variability in the two types of regions. The stable and unstable regions revealed a relationship of their variability with the aspect of mountain barriers with W to NW barriers having stable regions and SW to S barriers having unstable regions. There basic and persistent patterns of annual SN values surfaced: years with a consistent anomaly over the entire region (wet or dry); years with a distinct north-to-south gradient patterns occurred only before 1974 and dry-north/wet-south gradient patterns occurred only before 1974 and dry-north/wet-south gradient patterns did not occur before 1973. The long-term wet and dry periods experienced in the northern and southern regions of the five-state region are due to north-to south gradient patterns. (USGS)

#### Field 2—WATER CYCLE

#### **Group 2B—Precipitation**

W91-09824

ECOLOGICAL CLASSIFICATION OF THE CLIMATE OF THE RHINE CATCHMENT.

CLIMATE OF THE RHINE CATCHMENT. Agricultural Univ., Wageningen (Netherlands). Dept. of Physical Planning. R. H. G. Jongman. International Journal of Biometeorology IJBMAO, Vol. 34, No. 3, p 194-203, 1990. 6 fig, 2 tab, 32 ref.

Descriptors: \*Catchment areas, \*Climatology, \*Ecosystems, \*Meteorology, \*Rhine, \*Watersheds, Alpine regions, Climatic data, Evapotranspiration potential, Humidity, Marine climates, Precipitation, River basins, Temperate zone.

An ordination and classification was carried out on An ordination and classification was carried out on the climate of the Rhine catchment based on data from meteorological stations. The objective of the classification was to provide an ecological interpretation of climate data. The climate of northern France, Belgium, Luxembourg, the Netherlands, the Federal Republic of Germany and northern Switzerland is divided into five classes: (1) Alpine climate; this is typified by low temperature, high precipitation and a low relative air humidity for all months, especially summer; (2) Humid lower precipitation and a low relative air humidity for all months, especially summer; (2) Humid lower mountain climate; this is characterized by lower precipitation than the Alps, and precipitation is still higher than in all other parts of the research area; the high relative air humidity in July and September 10 to the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the Alpira children and the contractive this class from the children and the contractive this contractive this contractive that the children are contracted to the children and the ber differentiates this class from the Alpine cliber differentiates this class from the Alpine Climate; (3) Cold lower mountain climate; precipitation is less important in this class than in classes I and 2, but is higher than the next two classes; most characteristic is the low potential evapotranspiration in January, March, July, September and November; (4) Subcontinental climate; this class is characterized by low relative air humidity in July, September and November compared to class 5 and a relatively high precipitation in March, May, July and September; this class shares with class 5 lower precipitation than classes 1-3; (5) Atlantic climate; this is typified by high potential evapotranspiration in autumn and winter and low winter precipitation and high relative air humidity. The climate classes can be interpreted ecologically and are correlated with floristic and vegetation data. The Rhine valley has a distinctive and characteristic climate. Interpolation of the classification was not carried out because of the uneven geographical spread of the sites in the dataset. (Sand-PTT) W91-09954

SATELLITE MICROWAVE MEASUREMENTS OF ATMOSPHERIC WATER VAPOUR AND MARINE WIND SPEED; CASE STUDY APPLI-

Cape Town Univ. (South Africa). Dept. of Ocean-

ography. M. R. Jury, and D. Waliser. South African Journal of Marine Science SJMSE7, Vol. 9, p 309-316, 1990. 4 fig, 22 ref.

Descriptors: \*Air circulation, \*Marine environ-Descriptors: "Air circulation, "Marine environ-ment, "Remote sensing, "Satellite technology, "South Africa, "Water vapor, "Wind speed, Air-mosphere, Case studies, Data acquisition, Data in-terpretation, Floods, Meteorology, Model studies, Mozambique Channel, Precipitation, Water circu-lation, Weather.

Vertically integrated atmospheric water vapor and vertically integrated atmospheric water vapor and a surface wind speed over the oceans are derived from the SSM/I microwave sensor aboard the DMSP F8 satellite. Water vapor and wind fields surrounding southern Africa are analyzed for anomaly structure over the period which included the floods of 1988 from January 16 to March 31. Positive anomalies of water vapor during the pack Positive anomalies of water vapor during the peak flood episodes originate from the Mocambique Channel. Surface winds were particularly strong over the Agulhas Current. The spatial pattern points to a strengthening of the Hadley circulation points to a strengthening of the Hadley circulation cell and to west-moving convective systems which drew moisture from the southwestern Indian Ocean to the central plateau of South Africa. The SSM/I sensor fills an important gap in marine meteorological observations. Understanding of airsea interaction processes and the marine weather system structure can be expected to improve as SSM/I data find their way into routine synoptic weather analyses and models. (Brunone-PTT) W91-10012

APPLICATIONS OF SCIENTIFIC MODELING OF HYDROLOGIC RESPONSES FROM HY-POTHETICAL SMALL CATCHMENTS TO ASSESS A COMPLEX CONCEPTUAL RAIN-FALL-RUNOFF MODEL.

Washington Univ., Seattle. Dept. of Civil Engi-

neering. T. Y. Gan.

T. Y. Gan.
Available from the National Technical Information
Service, Springfield, VA. 22161, as PB90-134107.
Price codes: Al3 in paper copy, A01 in microfiche.
University of Washington Water Resources Series
Technical Report No. 111, June 1988. 259p, 46 fig,
19 tab, 158 ref, 6 append.

Descriptors: \*Evaluation, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Small watersheds, Evapotranspiration, Floods, Infiltration, Mathematical equations, Mathematical models, Precipitation, Runoff, Slopes, Streamflow,

Conceptual rainfall-runoff (r-r) models, which have been used extensively for simulating catch-ment streamflow, have limitations when operated beyond the range of calibration or validation experience; there is no guarantee that they will predict runoff accurately. This potential shortcoming is investigated by evaluating, in prediction and forecasting modes, the performance of an explicit soil moisture-accounting model, the Sacramento model (SMA) of the US National Weather Service. The evaluation process uses streamflow data generated by a hillslope r-r causal model (S-H) which can simulate interdependent surface and subsurface hy-drologic processes precisely for hypothetical small catchments, its output can be regarded as error-free'. To model infiltration, S-H replaces the 1-dimensional Richards' equation with a computa-tionally efficient, kinematic model which was dem-onstrated to be reliable for soils with saturated hydraulic conductivities > or = 0.02 m/hr. S-H's effectiveness was demonstrated further by its accueffectiveness was demonstrated furtner by its accurate comparisons of steady-state aquifer profiles with those from an analytical model. Eighteen numerical experiments, comprising combinations of three sets of input data (hourly precipitation and evapotranspiration data) and five hypothetical two-layered small catchments (areas < or = 0.5 sq km; saturated hydraulic conductivity from 0.02 to 0.3 cm, set of the conductivity from 0.02 to 0.3 cm, set of the conductivity from 0.02 to 0.3 cm, set of the conductivity from 0.02 to 0.3 cm, set of the conductivity from 0.02 to 1.3 cm, set of the conductivity from 0.02 to 1.3 cm, set of the conductivity from 0.02 to 1.3 cm, set of the conductivity from 0.02 to 1.3 cm, set of the conductivity from 0.02 to 1.4 cm, set of the conductivity km; saturated hydraulic conductivity from 0.02 to 0.2 m/hr; soil depth from 0.8 to 1.6 m; hillslope length from 100 to 250 m, and slope from 0.04 to 0.10), representing a wide range of flow mechanisms, were conducted. A manual and automatic approach was adopted to calibrate SMA which approach was adopted to cambrate SMA which was assessed in terms of graphical plots and summary statistics. The calibrated SMA could simulate fundamental flow mechanisms but generally performed poorly during dry to wet catchment transitions. Difficulties in calibration and model structure limitations of SMA are the main causes of tions. Difficulties in calibration and model struc-ture limitations of SMA are the main causes of inaccurate SMA predictions. SMA was found to unreliable in forecasting extreme flood events, for each case, the sum of the SMA conceptual storage differed from the physical catchment storage. (Au-thor's abstract) thor's abstract)

CLOUD CHEMISTRY AND OCCURRENCE IN THE WESTERN UNITED STATES: A SYNOP-SIS OF CURRENT INFORMATION, Oregon State Univ., Corvallis. Dept. of General

Science.
P. S. Muir, and M. Bohm.

F. S. Mult, and M. BOHII. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134248. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/217, June 1989. 31p,

Descriptors: \*Atmospheric chemistry, \*Chemical analysis, \*Cloud chemistry, \*Clouds, Acid rain, Air pollution, Alaska, Ammonia, California, Hydrogen ion concentration, Nitrates, Oregon, Sulfates, Washington.

Cloud water chemistry differs among regions (southern CA to coastal AK). Most variability in

the data can be attributed to differences in the total dissolved ionic concentrations among sites. Ionic concentrations generally decrease from urban/in-dustrial sites in southern CA toward forested sites in more remote, northern areas. Differences in cloud water chemistry among sites generally appear greater than differences among events at a appear greater than differences among events at a given site. Samples from southern CA are generally more acidic than those from the more northern sites (mean minimum pHs = 2.52 and 4.48, respectively). Southern CA samples tend to be dominated by SO4(2-), No3(-), and NH4(+), while samples from AK, OR, and northern CA are mainly influfrom AK, OR, and northern CA are mainly influenced by marine constituents. Most cloud interception is anticipated along the Pacific coast in the Coast Range of northern Ca, OR, and WA and along the western slopes of the Cascades. The available data on cloud water chemistry indicate that these regions experience clouds of relatively that these regions experience clouds of relatively low ionic concentrations, however the limited data should be supplemented to substantiate this result. Little can be stated on cloud chemistry and occur-rence in other regions of the West given the pauci-ty of data. (Author's abstract) W91-10079

HYDROLOGICAL NETWORK BASED ON AN INSTRUMENT FOR AUTOMATIC VARIABLE DATA ACQUISITION.

Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 7A. W91-10117

STUDY OF HYDROLOGICAL REGIMES IN EXPERIMENTAL BASINS IN RELATION TO CULTIVATION PRACTICES. Institutul de Meteorologie si Hidrologie, Bucharest

P. Stanciu, and I. Zlate-Podani. In: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 193-203, 9 fig, 2 tab, 2 ref.

Descriptors: \*Agricultural practices, \*Correlation analysis, \*Cultivated lands, \*Experimental basins, analysis, "Currivated lands," Experimental basins, "Hydrological regime, "Land management, "Rain-fall-runoff relationships, Antecedent precipitation index, Cropland, Erosion control, Model studies, Permeability, Rainfall intensity, Romania, Runoff coefficient, Runoff forecasting, Slopes, Soil porosi-ty, Veneticien offsets. ty, Vegetation effects.

In order to establish the relationships between runoff and its controls, data sets for rainfalls and floods were analyzed for two representative basins in Romania. Correlations were established between the depths of runoff and rainfall; the runoff coefficient, the rainfall intensity, and the antecedent precipitation index; the runoff coefficient, the rainfall depth, and the type of crop. Erosion and its control were studied in relation to the type of crop by means of instrumented runoff plots on hillslopes and subbasins. The studies carried out in the two experimental basins led to the following conclu-sions: (1) the occurrence of maximum discharges is due to the correlation of rainfall intensity with high soil moisture contents; (2) the vegetation cover significantly diminishes the runoff; (3) an important role is played by soil porosity and other physical characteristics of the soil, particularly the physical characteristics of me son, particularly me permeability; (4) building terraces on the hillslope largely diminishes runoff (up to 100%); and (5) the effect of the slope and of specific vegetation cover is obvious both on the maximum discharge, and on the depth of runoff. Experimental basins and runoff plots are very useful methods for studying hydrological regimes as they are influenced by charac-teristics of the land and cultivation practices. The results of these studies may be taken into account in specifying the methods for extrapolating the parameters from experimental plots and basins to large basins. These data help in developing the techniques for the mathematical and physical modeling of the rainfall-runoff process and in improv-ing the computation methodology of the overland runoff and small river parameters both in natural and modified flow regimes. (See also W91-10103) W91-10122

HYDROCLIMATIC CONSEQUENCES OF CLI-MATIC EVENTS IN WEST AFRICA: THE LES-SONS OF THE 1969-1984 SAHELIAN DROUGHTS.

Lagos Univ. (Nigeria). Dept. of Geography.
O. Ojo.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 229-238, 2 fig, 12 ref.

Descriptors: \*Africa, \*Arid-zone hydrology, \*Climatology, \*Drought, \*Drought effects, \*Hydrologic budget, \*Hydrological regime, \*Sahel, Climatic changes, Data requirements, Evaporation, Hydrologic models, Precipitation, Rainfall-runoff relationships, River basins, Streamflow data.

The disastrous droughts which afflicted subsaharan Africa in the early 1970s have reappeared and have attracted widespread attention, demonstrating the need to answer a number of questions relating to the characteristics of climatic events, their consequences and the prospects of their predictability, amelioration, and control. Some aspects of the hydroclimatic consequences of the 1969-1984 droughts have been examined with respect to their effects on the water balance components, relating drought characteristics to streamflow data within some river basins in the region. The index used for defining drought emphasizes the concept of rainfall variability, which is the time series of the normalized annual departures of rainfall in the region. The three inflow components of the water balance calculations were precipitation (most significant), irriculations were precipitation (most significant), irri-gation, and dew; the outflow components included were evaporation or evapotranspiration (most sig-nificant), and the net runoff. Evaporation values were computed for the runoff and discharge data for some rivers of West Africa. Generally, droughts were found to be relatively persistent and widespread throughout the Sahel region between 1969-1984; however, a lot of regional variations occurred in intensity, persistence, and spatial coverage of the droughts. The consequences of the droughts on the hydroclimatic parameters include variations in river regimes and discharge (especial-ly east of the sahel region) and reduction of validi-ty of generalization of climatic events from a large area to a small area. There is a need for a better understanding of the dynamics of the hydromeametrianium of the dynamics of the hydroneteorological components particularly for better parameterization, which is needed for a substantial improvement in hydrological models. In order to ascertain and improve the validity of research reascertain and improve the valuely of research re-sults, there is also a need for improvement in availability of data and information on hydrome-teorological parameters. (See also W91-10103) (Fish-PTT) W91-10125

FUTURE OF RAINFALL-RUNOFF MODEL-LING IN ARID AREAS--LAKE EYRE CASE STUDY

South Australian Dept. of Engineering and Water Supply, Adelaide. V. Kotwicki.

V. Kotwicki.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 341-351, 2 fig. 2 tab, 26 ref.

Descriptors: \*Arid-zone hydrology, \*Australia, \*Lake Eyre, \*Lake basins, \*Model studies, \*Rainfall-runoff relationships, Case studies, Closed lakes, Drainage area, Hydrologic data, Hydrologic data collections, Hydrologic models, Soil water.

Arid and semiarid areas are expanding, already covering one-third of the world's land masses. The case study of the Lake Eyre basin in Australia is one examination of the hydrology of these vast areas. Lake Eyre is a terminal point of the great intercontinental drainage system spread over 1,400,000 sq km of arid central Australia. All streams are characterized by extreme variation in discharge and flow duration; mean annual runoff of the basin is 4 cu km or 3.5 mm in depth, the lowest of any major drainage system in the world. Natural

groundwater recharge is estimated at 0.03 cu km/ yr. Some other characteristics of the basin include average annual rainfall of 100-500 mm, mean annual evaporation ranging from 2400-3600 mm, annual evaporation ranging from 2400-3000 mm, substantial change in water regime effected by even minor climatic change. It has been found that the annual inflow from 51 floods in the period 1885-1984 averaged 3.8 cu km, with a standard deviation of 6.2 cu km. Detailed investigation of the water resources of particular tributaries and sub-basins would require a much denser hydrome-teorological data network. The requirements of ch a network for future modeling needs include: real-time data collection, transmission, and processing; greater network density; self-reporting raingages; streamflow devices able to measure flow gages; streamilow devices able to measure flow cross-section and integrate flow velocities; ground verification of satellite imagery; and data transmis-sion by meteorburst technology. It can be expected that soil moisture accounting models will be par-ticularly useful in arid and semiarid areas, enabled by the new data collection, transmission, and processing techniques. (See also W91-10103) (Fish-PTT W91-10135

PARAMETER DETERMINATION AND INPUT ESTIMATION IN RAINFALL-RUNOFF MOD-ELLING BASED ON REMOTE SENSING TECHNIQUES.

Ruhr Univ., Bochum (Germany, F.R.).

G. A. Schultz.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 425-438, 6 fig, 1 tab, 15 ref.

Descriptors: "Hydrologic data collections, "Hydrologic models, "Model studies, "Parameter estimation, "Parametric hydrology, "Rainfall-runoff relationships, "Remote sensing, Distribution, Flood forecasting, Input-output analysis, Probable maximum precipitation, Runoff forecasting, Satellite technology, Spectral analysis.

In rainfall-runoff modeling three consecutive steps usually must be taken: choice of an adequate model structure, estimation of the model parameters, and selection of the model input data. Remote sensing (RS) has potential use for parameter determination and input estimation, because it always produces areal information instead of point meas RS measurements of major importance in hydrology are multispectral air photography, echo sound-ers for sediment measurements, ultrasonic velocity measurements in rivers, laser techniques for various measurements, ground-based weather radar for quantitative rainfall measurements as a basis for runoff computations, satellite measurements from polar orbiting or geosynchronous satellites in various spectral bands, and space shuttle measurements. The resolution in space of the model structure, the parameters, and the input data must be in good agreement. The full potential of RS data can be considered only be used of distributed models. be exploited only be use of distributed models, taking advantage of the high resolution of RS data in space. On the other hand, there are problems which can be solved with the aid of lumped models using RS data in a form adapted to such problems. In some cases RS data are used only to estimate model parameters, while the model input stems from other sources (usually, if distributed models are applied); in other cases the same type of RS data is used for both parameter estimation and model input determination. The estimation of model input data from RS sources was considered for three types of problems: (1) rainfall estimation with the aid of weather radar for flood forecasting, (2) rainfall estimation for runoff computation from (2) raintal estimation for more computation from geostationary satellites, and (3) runoff estimation (monthly values) for design purposes using image-ry from polar orbiting satellites. It was concluded that, since several RS data acquisition systems provide simultaneous information on various spectral nds, models have to be developed which can make efficient use of the information obtained from all relevant spectral channels. (See also W91-10103) (Fish-PTT)

AUTOMATIC ASSESSMENT OF RAINFALL AND ITS EVALUATION-EXPERIENCE
THE FEDERAL REPUBLIC OF GERMANY. Stuttgart Univ. (Germany, F.R.). Inst. fuer Was-

J. Giesecke, and H. Meyer.

IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 463-475, 6 fig, 3 tab, 14 ref.

Descriptors: "Areal precipitation, "Automation, "Data acquisition, "Hydrologic data collections, "Measuring instruments," Meteorological data collection, "Rain gages, Data processing, Digital computers, Electronic recorders, Germany, Instrumentation."

Increasingly higher demands are made for precipitation measurement. Conventional analog recorders with a minimum time interval of 5 minutes represent the limit of point measurements. If areal rainfalls are measured by a network, the time interval often must be extended. With the use of the tripping bucket (rocker principle) and an electronic data processing system (Ram-Pack with microelectronic processors serving as data collectors), it has been possible to develop and to produce digital measurements utilizing the Hellmann recording rain gage. This guarantees the continuity of existing measurements. The time interval of these measurements can be reduced to seconds as well as allowing the processing of data to be considerably improved and simplified. (See also W91-10103) (Author's abstract) W91-10145

POINT PRECIPITATION MEASUREMENTS: WHY ARE THEY NOT CORRECTED.

Eidgenoessische Technische Hochschule, Zurich (Switzerland). B. Sevruk.

IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 477-486, 5 fig, 12 ref.

Descriptors: \*Data quality control, \*Error analysis, \*Hydrologic data collections, \*Measuring instruments, \*Meteorological data collection, \*Rain gages, Data processing, Errors, Gages, Precipitation, Rain, Rainfall.

Knowledge of precipitation is based on point measurements obtained from can-type gages exposed above ground level, a technique applied and unchanged since the early days of civilization. Such measurements are subject to a systematic error of up to 50%. This error has been known and efforts to eliminate it been made since the seventeenth century. From that time, a myriad of papers has century. From that time, a myriad of papers has been published suggesting protection measures or correction procedures. Yet the precipitation measurements are still not corrected. In the past, there were no correction procedures, and thus it was not possible to correct the precipitation values for the systematic error. Many problems seemed to be impossible to solve until very recently; the first operationally applicable correction procedures became known only at the beginning of the 1960s. Since then, the subject of correction procedures has developed and will continue to develop. In the meantime, new and better methods of precipitation meantime, new and better methods of precipitation measurements are being developed, such as ground-level gages and 'bush shelter' measurement techniques. However, the only improvement possible at present is the introduction of corrections for the systematic error in precipitation data into the the systematic error in precipitation data into the network measurements on an operational basis. Future prospects include regular comparison be-tween the conventional gages of various types and reference (protected) gages, complemented by lab-oratory tests of the physical properties of the gages, in order to provide the data sets required to compare and to test various correction procedures under different climatological conditions and to select a suitable procedure for operation of both old and new gages. (See also W91-10103) (Fish-PTT)

#### **Group 2B—Precipitation**

MODELLING CLIMATIC CHANGE IN SOUTHERN AFRICA: A REVIEW OF AVAIL-

ABLE METHODS.
University of the Witwatersrand, Johannesburg
(South Africa). Climatology Research Group.

South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 318-330, July/October 1990. 13 fig.

Descriptors: \*Africa, \*Climatic changes, \*Climatology, \*Future planning, \*Global warming, \*Mathematical models, \*Model studies, Drought, Greenhouse effect, Rainfall, Rainfall distribution, Tropical climates, Weather patterns.

Climatic change is as old as the atmosphere and has occurred for thousands of millions of years. Both individual and globally-averaged oxygen isotope records from deep-sea sediment cores indicate the extent to which climate has fluctuated over the last two million years. Since the turn of the century is resinful user posts of the support sainful resinful. ry, rainfall over most of the summer rainfall region of South Africa has varied in a systematic way. Climatic change has been modeled using statistical models, energy balance models, radiative-convections. tive models, numerical weather forecasting, and general circulation climate models (GCM). Be-cause of considerable public interest in future cli-matic change, GCM predictions are favored for matic change, GCM predictions are favored for regional climatic assessment. The climate simulations of the present GCMs still have many deficiencies and the additional computer power needed to develop the newest coupled models remains a major problem. Based on current knowledge, equatorial-tropical areas appear to be less likely to be affected adversely by greenhouse-induced climatic change in the future than the subtropical and adjacent regions. All future planning must be based on the assumption that the subtropical countries of southern Africa are lands of drought rather than of rainfall plenty. (Brunone-PTT) PTT) W91-10182

CLIMATE CHANGE AND HYDROLOGICAL RESPONSE IN SOUTHERN AFRICA: HEAD-ING TOWARDS THE FUTURE.

Natal Univ., Pietermaritzburg (South Africa). Dept. of Agricultural Engineering.

R. E. Schulze.

South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 373-381, July/October 1990. 8 fig, 1

Descriptors: \*Climatic changes, \*Climatology, \*Evaporation, \*Future planning, \*Global warming, \*Hydrology, \*Precipitation, \*South Africa, \*Temperature effects, \*Transpiration, \*Water resources management, Economic aspects, Greenhouse effect, Hydrologic cycle, Rainfall distribution, Runoff, Water quality trends.

Many important economic and coastal decisions are being addressed on long term projects, includ-ing major water resources management activities dependent upon the availability of surface of ground waters. The global circulation models ground waters. The global circulation models (GCM) are predicting a mean global rise in surface temperature of 1.5 to 4.5 C for a doubling of atmospheric CO2 content which could take place in the next 50 to 70 years. In the global terrestrial instance of the could take place in the next 50 to 70 years. In the global terrestrial instance of the country of the count ad waters. in the next 50 to 70 years. In the global terrestrial hydrological balance the evaporation component, to which transpiration is a significant contributor, accounts for 70% of all the precipitation that falls; in southern Africa 91% of all precipitation evaporates and transpires again and only 9% is converted to runoff. Responses of precipitation to possible changes in temperature are not yet understood satisfactorily nor are they easily substantiated by paleoclimatic evidence. Possible temperature change-induced rainfall scenarios over southern Africa include the reduction in thermal gradients latitudinally causing a decrease in the interannual latitudinally causing a decrease in the interannual variability of precipitation; overall, an increase in variability of precipitation; overall, an increase in precipitation; rainbelts are expected generally to shift polewards; summer rains might start earlier in spring and last longer into autumn; and the present winter rainfall regions associated with less intense frontal rainfall might shift polewards and be replaced partially by summer rainfall distributions. Not only would open water evaporation rates in-

temperature but an array of chemical and biological water quality related repercussions are likely. Global climate change impacts will challenge hydrological researchers. (Brunone-PTT) W91-10183 crease with a carbon dioxide-induced increase in

EFFECT OF OCEANOGRAPHIC VARIABILITY ON SOUTH AFRICAN WEATHER AND

Cape Town Univ. (South Africa). Dept. of Ocean-

ography. N. D. Walker, and F. A. Shillington. South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 382-386, July/October 1990. 5 fig,

Descriptors: \*Atmosphere, \*Climatic effects, \*Marine environment, \*Meteorology, \*Ocean currents, \*Oceanography, \*Oceans, \*Rainfall, \*South Africa, \*Weather patterns, Air temperature, Boundary layers, Coasts, El Nino/Southern Oscillation, Seasonal variation, Water temperature.

Warm ocean currents can affect the climate of adjacent coastal areas. How variations in oceanic temperatures influence continental climates and rainfall is less well understood. The best known interannual atmosphere-ocean feedback system is the El Nino-Southern Oscillation (ENSO). South Africa occupies a unique geographic position in the context of the world ocean, because it is influ-enced by a warm western boundary current system to the east and south (Agulhas) and by a cold eastern boundary current system to the west (Ben-guela). South African workers have lined local climate and rainfall to interannual global ENSO events. Further recent research has demonstrated events. Further recent research has demonstrated that significant positive correlations exist between interannual sea surface temperature variability within the Agulhas Current system and South African summer region rainfall variability in the absence of ENSO events. The detailed mechanisms by which the changes in sea temperature are linked to altered rainfall patterns must be examined. One of the most important oceanic areas identified is the Agulhas Current Retroflection region to the south of the country, which feeds large amounts of heat and moisture into the marine boundary layer. neat and moisture into the marine boundary layer. Under certain synoptic conditions, this modified marine boundary layer is available to influence the South African weather and climate directly. Cor-relation studies between oceanic surface tempera-tures and South African summer rainfall have shown the importance of the surrounding ocean to the climate and rainfall of the country. (Author's

VEGETATION CHANGE IN A SEMI-ARID SUCCULENT DWARF SHRUBLAND IN THE

SUCCULENT DWARF SHRUBLAND IN THE EASTERN CAPE, SOUTH AFRICA. Rhodes Univ., Grahamstown (South Africa). A. R. Palmer, C. G. Hobson, and M. T. Hoffman. South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 392395, July/October 1990. 9 fig, 2 tab, 25 ref.

Descriptors: \*Plant-water relationships, \*Semiarid climates, \*Shrubland, \*South Africa, \*Succession, \*Vegetation effects, Bioindicators, Mathematical models, Model studies, Rainfall distribution, Species composition, Statistical analysis.

A model of vegetation change in the succulent dwarf shrublands of the Camdebo plain, eastern Cape, is presented using the results of eight 2000-point samples collected from 1950 to 1988. Three models are developed using reciprocal averaging, two-way indicator species analysis, and trend analysis. All the models suggest a gradient of change from 1950 to 1988. The gradient is examined for trends using component line charts of basal cover with 95% confidence limits. The analysis shows an increase in annual and perennial grasses (Poaceae). increase in annual and perennial grasses (Poaceae), fluctuations in perennial dwarf shrubs, returning to the 1956 levels in 1988, and stability in succulent dwarf shrubs (Aizoaceae and Mesembryanthema-ceae). Comparison with an adjacent paired plot, subjected to short-duration grazing, suggests that these changes are a consequence of favorable man-

agement by the grazier. Changes in rainfall seasonality did not provide an explanation for the fluctuations in grasses and perennial dwarf shrubs. Time series analysis of rainfall data confirmed the presence of a wet-dry oscillation. (Author's abstract) W91-10185

ASSESSMENT OF IMPACTS ASSOCIATED WITH DRIER OR WARMER SCENARIOS. University of the Witwatersrand, Johannesburg (South Africa). Dept. of Geography and Environmental Studies.

C. H. Vogel.
South African Journal of Science SAJSAR, Vol.
86, No. 7-10, p 447-450, July/October 1990. 2 fig, 1

Descriptors: "Climatic changes, "Climatic effects, "Drought effects, "Future planning, "Global warming, "South Africa, "Water supply, Crop production, Greenhouse effect, Land loss, Land use, Rainfall distribution, Water conservation.

Projections have been made for drier conditions and the increased frequency of droughts in South-ern Africa associated with the enhanced green-house effect. The need to measure the ramifications of such future warming requires the identification of some of the impacts associated with the 1980s droughts in Southern Africa, and the illustra-1700s droughts in Southern Arrica, and the mustra-tion of the methodological approach important in determining the results of impact research. Rainfall fluctuations appear to span large areas. The analy-sis of impacts of droughts have not been studied using both direct and interactive approaches to provide a comprehensive drought impact assess-ment. The impact approach includes an analysis of the consequences of a disturbance on an 'exposure unit', such as maize production, in terms of direct cause and effect. In an interactive approach, both cause and effect. In an interactive approach, both social and physical approaches are considered as converging to provide a detailed picture of numerous processes that may exacerbate a drought. The consequences of the 1980s drought in Southern Africa were many and varied, ranging from reduced agricultural production and water supply to water restrictions and the role that land degradation played in highlighting the drought. (Brunone-PTT) W91-10191

CLOUD COVER DETERMINATION IN POLAR REGIONS FROM SATELLITE IMAGERY.

Cooperative Inst. for Research in Environmental Science, Boulder, CO. For primary bibliographic entry see Field 7B. W91-10251

METEOROLOGICAL INFLUENCES ON MOUNTAIN CLOUDWATER CHEMISTRY IN THE EASTERN USA.
Oregon State Univ., Corvallis. Dept. of Atmos-

heric Science For primary bibliographic entry see Field 5B. W91-10257

RADIATION, TEMPERATURE AND RAIN-FALL REGIMES OF THE FLOODPLAIN

FALL REGIMES OF THE FLOODPLAIN FOREST ECOSYSTEM.

I. Uhrecky, Z. Smolik, V. Havlicek, and R. Mrkva. IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 33-59, 12 fig, 18 tab, 11 ref.

Descriptors: \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Forest ecosystems, \*Meteorology, \*Weather patterns, Canopy, Interception, Precipitation, Radiation, Soil temperature, Soil

Selected meteorological elements were measured ans analyzed along a vertical profile of the flood-plain forest at Lednice na Morave, Czechoslovakia for the period 1970-1974. The region is classified climatically as warm and dry, with a moderate winter and relatively little sunshine. The moisture

#### Precipitation—Group 2B

conditions are dry to subhumid. The net radiation for individual levels of the floodplain forest, expressed as a percentage of net radiation above the canopy, decreases with decreasing height for both clear and overcast days. On clear days it is 53% in the canopy layer, 16% in the shrub layer, and 6% in the herb layer. The mean air temperature decreases with height, so that it is 1.6 C lower in the herb layer. The state of the series of the state. creases with height, so that it is 1.6 C lower in the herb layer than above the stand. The soil surface is heated mainly during the day, and the extent of warming up decreases with depth. The soil surface generally cools at night, and the cooling decreases with depth. This is why the daily amplitude is highest at the soil surface, and why it decreases with depth. The wind speed decreases from above the canopy to the canopy level. In the course of the day, it increases with the increasing intensity of the property of the canopy level. In the course of the day, it increases with the increasing intensity of urbulent exchange, and attains a maximum beturbulent exchange, and attains a maximum be-tween 1400 and 1500 hrs. Then it decreases in parallel with the decreasing exchange intensity, towards a minimum between 2000 and 2100 hrs. In general, the years of this study had low precipita-tion. On average, it was 22% lower, and in 1973 it usa. 38% lower than the long-term (1901-1950) average of annual totals (524 mm). The dynamics of interception showed no distinct differences between the foliated and leafless phases. (See also W91-10298) (White-Reimer-PTT)

LARGE SCALE EFFECTS OF SEASONAL SNOW COVER.
For primary bibliographic entry see Field 2C.
W91-10338

LARGE-SCALE EFFECTS OF SEASONAL SNOW COVER.

Illinois Univ. at Urbana-Champaign. J. E. Walsh.

J. E. Walsh. IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 3-14, 6 fig, 18 ref. NSF Grant ATM-8507782.

Descriptors: \*Atmospheric circulation, \*Climatology, \*Cyclones, \*Global warming, \*Snow, \*Snow cover, Climates, General circulation models, North America, Seasonal distribution, Snow sur-

The effects of snow cover on large-scale atmospheric circulation have been examined through composite analyses derived from observed synop-tic events and through a series of 30-day forecasts from the global circulation model of the National Center for Atmospheric Research. Both approaches have focused on the eastern North American region. The composite analyses show that extensive snow cover favors more rapid intensification and northward trajectories of cyclones along the eastern margin of the continent. The 30-day model eastern margin of the continent. The 30-day modes experiments indicate a qualitatively similar response in which sea level pressure is higher inland and lower along the coast when extensive snow cover is prescribed. The present findings are consistent with the shallowness of the local response in both data-based and model results. Nevertheless, the coalification of the collaboration is the coalification of the collaboration o both data-based and moder results. Nevertheless, the modification of the sea-level pressure regime in eastern coastal regions of mid-latitudes emerges as a detectable signal. The possibility that a CO2-induced warming may alter systematically the extent of winter snow cover makes snow cover a key variable in scenarios of global warming. (See also W91-10338) (Rochester-PTT) W91-10339

SNOW COVER AS AN INDICATOR OF CLI-MATE CHANGE, Lamont-Doherty Geological Observatory, Pali-

sades. NV. For primary bibliographic entry see Field 2C. W91-10340

SNOW COVER-ATMOSPHERIC INTERAC-TIONS.

Nebraska Univ., Lincoln. Dept. of Geography. K. E. Dewey. IN: Large Scale Effects of Seasonal Snow Cover.

Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 27-42, 8 fig, 3 tab, 16 ref.

Descriptors: \*Atmospheric circulation, \*Climatology, \*North America, \*Snow, \*Snow cover, Altitude, Correlation analysis, Cyclones, Gulf states,

Digitized weekly snow cover maps were employed to investigate snow cover-atmospheric interactions. Several height fields were correlated with snow cover extent for North America on a concurrent as well as a positively-lagged and negatively-lagged basis. Concurrent relationships, and lower upper-air level height fields, were the most significantly correlated. Examining cyclonic paths the cantly correlated. Examining cyclonic paths, the frequency of cyclones appeared to increase across the southeastern United States during extensive snow cover years. Winter tornado outbreaks across snow cover years. Winter tornado outbreaks across the Gulf states also appeared to be directly modulated by the extent of North American snow cover. Several United States regions high spring time correlations between continental snow cover extent and tornado frequency. A comparison of tornado/snow cover anomalies produced the most promising 'snow cover influence' results. (See also W91-10381) (Author's abstract)

PARAMETERIZATION OF SNOW ALBEDO FOR CLIMATE MODELS.

Cooperative Inst. for Research in Environmental Science, Boulder, CO. For primary bibliographic entry see Field 2C. W91-10342

SEASONAL VARIATION OF EURASIAN SNOW COVER AND ITS IMPACT ON THE INDIAN SUMMER MONSOON.
Nairobi Univ. (Kenya). Dept. of Meteorology.
For primary bibliographic entry see Field 2C.
W91-10343

STATISTICAL STUDIES OF THE ATMOSPHERIC CIRCULATION OF THE NORTHERN HEMISPHERE, HYDROCLIMATIC REGIMES IN CHINA AND ANTARCTIC SNOW COVER. Academia Sinica, Beijing (China). Inst. of Geography.

phy.

G. Peng, and M. Domros.

IN: Large Scale Effects of Seasonal Snow Cover.

Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. IAHS Publication 166, 1987. p 61-72, 3

fig, 4 tab, 12 ref.

Descriptors: \*Antarctica, \*Atmospheric circula-tion, \*China, \*Climatology, \*Northern hemi-sphere, \*Snow, \*Snow cover, Climates, Data interpretation, Forecasting, Hydrology, Pacific Ocean, Statistical analysis, Yellow River.

On the basis of 10-yr monthly and long-term annual data, the connections of different indices of the atmospheric circulation of the northern hemisphere, some hydroclimatic regimes in China, and Antarctic snow-ice indices were examined. Techniques employed included correlation, regression, stepwise regression, power-spectral analyses, and cross-spectral analyses. The results show that there are close correlations between some meteorologi-cal conditions in the northern hemisphere and Antarctic ice-snow cover, particularly between the northwestern Pacific subtropic high or the annual runoff of the Yellow River at Sammenxia station and the ice-snow indices. The strongest correlaand the ice-snow indices. Ine strongest correlations often appear with some time lags of the meteorological conditions and hydrological conditions behind the ice-snow variations. These connections are helpful for hydroclimatic forecasting. (See also W91-10338) (Author's abstract) W91-10344

INTERACTIONS BETWEEN THE SNOW COVER AND THE ATMOSPHERIC CIRCULATIONS IN THE NORTHERN HEMISPHERE. Tsukuba Univ. (Japan). Inst. of Geoscience

For primary bibliographic entry see Field 2C. W91-10345

IMPORTANCE AND EFFECTS OF SEASONAL SNOW COVER,

Eidgenoessisches Inst. fuer Schnee- und Lawinen-forschung, Davos (Switzerland).
For primary bibliographic entry see Field 2C. W91-10348

LARGE SCALE EFFECTS OF SEASONAL SNOW COVER AND TEMPERATURE INCREASE ON RUNOFF.

Agricultural Research Service, Beltsville, MD. Hydrology Lab.

A. Rango, and J. Martinec.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. IAHS Publication 166, 1987. p 121-127, 6
fig, 7 ref.

Descriptors: \*Climatology, \*Global warming, \*Mountain watersheds, \*Runoff, \*Snow, \*Snow cover, \*Snowmelt, \*Switzerland, Climates, Drought, Hydroelectric power, Navigation, Rhine River, Seasonal distribution, Temperature.

The seasonal snow cover influences runott in targe mountain basins and cold regions. Typical features of the snowmelt runoff are regular daily fluctuations and the absence of sharp, sudden peaks characteristic of rainfall floods. The effect of a possible contact of the collection o acteristic of rainfail floods. I he effect of a possible warmer future climate was studied by simulating snowmelt runoff in a large alpine basin (the Rhine at Felsberg, Switzerland) for hypothetically increased temperatures. In the first half of the snowmelt period, higher temperatures result in an increase in runoff, but this trend is reversed in the second half of the snowmelt period. The highest peak is reduced by a few percent and occurs peak is reduced by a few percent and occurs approximately one week earlier in June under the influence of the increased temperatures. The redistribution of river flows may have favorable as well as adverse effects. The increased runoff in April helps to meet high electricity demands. The lower runoff in late summer, if projected downstream, may exacerbate drought conditions, which sometimes interfere with river navigation in the autumn. However, the effect, even with a considerable increase in temperature, appears small. (See also W91-10338) (See also W91-10338) (Rochester-PTT) W91-10349

ESTIMATES OF POSSIBLE VARIATIONS OF SNOWMELT-RUNOFF CHARACTERISTICS AND CLIMATIC CHANGES.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem. L. S. Kuchment, G. Motovilov, E. Muzylev, and

N. A. Nazarov.

N. A. Nazarov.
Inv. Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. LAHS Publication 166, 1987. p 129-138, 1 fig, 3 tab, 3 ref.

Descriptors: \*Climatology, \*Global warming, \*Hydrologic models, \*Runoff, \*Snow, \*Snowmelt, \*Soviet Union, Climates, Kassansai River, Mathematical models, Precipitation, Seasonal distribution, Sosna River, Temperature, Vologda River.

Models of snowmelt runoff formation process were constructed and calibrated using available observation data for three drainage basins in different physiographic and climatic zones (Vologda River basin, Sosna River basin, and Kassansai River basin, all in the Soviet Union). Estimates of the sensitivity of hydrological systems to climatic changes have been obtained and possible variations of the runoff hydrograph under the effect of ex-pected man-induced climatic changes were esti-mated. The results show that a 5-10% increase in runoff may be expected from a 20-15% increase in winter precipitation and a 1-2 C increase in the air temperature for the northern part of the forest zone of the USSR. In more southern regions,

#### Field 2—WATER CYCLE

#### **Group 2B—Precipitation**

where antecedent moistening and soil freezing depth are important, these precipitation and tem-perature variations may lead to a decrease in spring flood volume. Relative snowmelt-runoff variations flood volume, relative sinument-fundor variations in mountain basins are similar to relative precipitation variations. A temperature increase of 2-3 C may result in a runoff decrease of 15-20%. (See also W91-10338) (Author's abstract)

MODELLING LARGE SCALE EFFECTS OF SNOW COVER.

SNOW COVER.
British Columbia Univ., Vancouver.
A. Pipes, and M. C. Quick.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. IAHS Publication 166, 1987. p 151-160, 6

Descriptors: \*Climates, \*Climatology, \*Mathematical models, \*Model studies, \*Runoff, \*Snow, \*Snow cover, \*Snowmelt, Albedo, British Columbia, Cloud cover, Energy, Floods, Himalayas, Hydrologic models, Mountain watersheds, Vegeta-

Large-scale effects of snow cover can be subdivid-ed into two major issues: the weather-modifying effect of energy balance over extensive snow cover and snowmelt flood production capability. Modification of tree cover is argued to be a sensitive factor in the energy balance and flood production. Equations are presented that define the energy available to the atmosphere and for snowmelt. If cloud cover, albedo, and wind data are not available, they are represented by using temperature data. This temperature-controlled energy balance method yields good estimates of point snowmelt for forested and open areas. The method was compared with the degree-day approach. Calculation of streamflow runoff from small mountain watersheds and from large mountain watersheds in Brit-ish Columbia and the Himalayas confirmed the usefulness of this temperature-controlled energy budget approach. (See also W91-10338) (Author's

#### 2C. Snow, Ice, and Frost

MODELLING THE BEHAVIOUR OF OIL SPILLS IN ICE-INFESTED WATERS.

Atmospheric Environment Service, Downsview For primary bibliographic entry see Field 5B. W91-09420

SURFACE RUNOFF AND SOIL WATER PER-COLATION AS AFFECTED BY SNOW AND SOIL FROST.

Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.

H. Johnsson, and L. C. Lundin. Journal of Hydrology JHYDA7, Vol. 122, p 141-159, January 1991. 9 fig,1 tab, 36 ref.

Descriptors: \*Frost, \*Infiltration, \*Model studies, \*Percolation, \*Runoff, \*Snow, \*Snowmelt, \*Sweden, Agriculture, Mathematical studies, Simulation analysis, Snow cover, Variability.

A coupled soil water and heat model was used to study the influence of soil frost and snow on infil-tration and drainage flow in an agricultural field in central Sweden. An analogy between freezing/ thawing and drying/wetting was assumed for the soil frost sub-model. Model simulations were evaluated against measurements of total soil water content, unfrozen water content, soil temperature and drainage water-flow. The influences of soil frost and spatial variation in snow cover were studied and spatial variation in snow cover were studied by simulation of possible extreme situations in the field. The model accurately described the dynamics of soil temperature and water contents; howev-er, infiltration and field drainage flow were considerably underestimated and delayed by about three weeks under frozen conditions. A model simula-tion, discounting the effects of soil frost, overesti-

mated the drain response. An attempt at simulating the field variation in snow cover by assuming possible 'sink points' for snowmelt explained part of the deviations between simulated and measured drain flows. A basis for a new model formulation of the infiltration and percolation processes in frozen soil is proposed in which two water-flow frozen soil is proposed in which two water-inow domains are assumed, one low-flow domain in the fine pores, smaller than those filled with ice, and one high-flow domain in the large air-filled pores. This allows the simulation of rapid infiltration in large ice-free pores and drainage flow under frozen conditions as well as the resulting redistribution of ice from smaller to larger pores. (Author's abstract) W91-09741

RELATIONSHIP BETWEEN THE DEVELOP-MENT OF DEPTH HOAR AND AVALANCHE RELEASE IN THE TIAN SHAN MOUNTAINS, CHINA.

Xinjiang Inst. of Geography, Urumqi (China). W. Ma, and R. Hu. Journal of Glaciology JOGLAO, Vol. 36, No. 122, p 37-40, 1990. 5 fig, 4 ref.

Descriptors: \*Avalanches, \*China, \*Depth hoar, \*Hoar frost, \*Snow cover, \*Tian Shan Mountains, Air temperature, Soil temperature.

Considerable amounts of solid precipitation occur in spring and winter in the western part of the Tian Shan mountains, in China. Avalanches occur frequently in these areas often endangering human life and construction projects. Observations show that the occurrence of avalanches is closely related to the decentrance of avalanties is closely related to the physical characteristics of the snow, especially to the development of depth hoar in the snow cover. Depth hoar develops when conditions are met for thickness of the snow cover, air temperature, ground temperature regime, and the duration of negative temperatures. The optimum depth of snow cover for the development of depth hoar is about 80 cm in the Tian Shan mountains. Consequently, depth hoar develops very well in this region since it has an average maximum depth of snow cover of 78 cm. As the thickness of depth hoar can exceed more than 80% of the total snowcover depth, the frequent occurrence of ava-lanches even under a limited snow-cover depth in the western part of the Tian Shan mountains is expected. (Author's abstract) W91-09941

AVALANCHE WEATHER FORECASTING AT THE NORTHWEST AVALANCHE CENTER, SEATTLE, WASHINGTON.

SEATILE, WASHINGTON.
Northwest Avalanche Center, Seattle, WA.
S. A. Ferguson, M. B. Moore, R. T. Marriott, and
P. Speers-Hays.
Journal of Glaciology JOGLAO, Vol. 36, No. 122,
p. 57-66, 1990. 5 fig, 2 tab, 10 ref, 2 append.

Descriptors: \*Avalanches, \*Forecasting, \*Meteorology, \*Oregon, \*Washington, Climates, Data acquisition, Model studies, Remote sensing, Safety programs, Terrain.

Since its inception in 1975, the Northwest Avalanche Center (NWAC) has developed and pro-duced micro-, and mesoscale weather forecasts to support avalanche forecasts and control needs for the Olympic and Cascade Mountains of Washing-ton and Oregon. NWAC has an array of data, observational results, and analytical techniques that make avalanche weather forecasting possible. More than 60 mountain stations supply weather More than 60 mountain stations supply weather and snowpack data at least once a day; some sites are interrogated eery hour. Data is also obtained from the U. S. National Weather Service (NWS), the Canadian Atmospheric Environment Service (AES), the U. S. Soll Conservation Service, and ski areas and mountain highway patrols. Satellite imagery of the area is available from the GOES West Satellite each hour and radar reports are available every few minutes. The synoptic prognostic models use AES and NWS data for initialization, but much of the model interpretation is provided by the individual forecaster. A sample forecast is given. This program has proven benefiforecast is given. This program has proven beneficial to highway maintenance and sr

grams throughout Washington and Oregon. (Author's abstract) W91-09942

SUBGLACIAL WATER PRESSURES AND THE SHAPE OF SUBGLACIAL CONDUITS,

Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics R. L. Hooke, T. Laumann, and J. Kohler

Journal of Glaciology JOGLAO, Vol. 36, No. 122, p 67-71, 1990. 5 fig. 1 tab, 16 ref. Swedish Natural Science Research Council and NSF Grants DPP-8414190, DPP-8619086 and INT-8712749.

Descriptors: \*Model studies, \*Subglacial water pressure, \*Water pressure, Ice, Mathematical models, Pressure conduits.

Measured subglacial water pressures are frequently higher than theoretical values calculated by assum-ing that subglacial conduits are straight and either circular or semi-circular in shape. While this may be attributed to errors in the estimates of conduit roughness or ice viscosity, an alternative explana-tion is suggested here: namely that the conduits are actually broad and low rather than semi-circular. Good agreement between measured and calculated pressures can be obtained by assuming that the cross-sectional shape of conduits resembles the space between the arc of a circle and its chord. The angle subtended by the arc, theta, is treated as an adjustable parameter. In four cases studied, theta ranged from 2-36 degrees. (Author's abstract) W91-09943 actually broad and low rather than semi-circular.

OBSERVATIONS ON THE DRAINAGE OF AN ICE-DAMMED LAKE IN WEST GREENLAND, Aberdeen Univ. (Scotland). Dept. of Geography. A. J. Russell, J. F. Aitken, and C. Jong. Journal of Glaciology JOGLAO, Vol. 36, No. 122, p 72-74, 1990. 4 fig, 5 ref.

Descriptors: \*Glaciers, \*Greenland, \*Ice-dammed lakes, \*Iced lakes, \*Lake morphology, Moraines, Sediment transport, Shear, Tunnels.

A small ice-dammed lake near Sondre Stromfjord, West Greenland, drained suddenly during the night of 15-16 July 1988. This drainage was ob-served from within the lake basin near the tunnel served from winth the lake oash hear the tunner mouth. The drainage had four main effects: the collapse of adjacent moraine ridges; the shearing of ice around the tunnel mouth; rapid incision of the lake bed; and the transport of sediment from the lake basin into the glacier. All of these were confined to a period of 15-30 min following the exponents of a civalit tunnel, for in disease. (Author) sure of a circuit tunnel 6 m in diameter. (Author's abstract) W91-09944

CONFIGURATION OF THE DRAINAGE SYSTEM OF MIDTDALSBREEN, NORWAY, AS INDICATED BY DYE-TRACING EXPERI-

Cambridge Univ. (England). Dept. of Geography. I. C. Willis, M. J. Sharp, and K. S. Richards. Journal of Glaciology JOGLAO, Vol. 36, No. 122, p 89-101, 1990. 8 fig. 3 tab, 42 ref.

Descriptors: \*Ablation, \*Drainage systems, \*Dye releases, \*Flow discharge, \*Flow velocity, \*Glaciers, \*Glaciology, \*Melting, \*Norway, Mathematical models, Snowmelt, Subglacial water pres-

During the summers of 1987 and 1988, 15 dye-tracer tests from a total of eight injection points were conducted in the ablation area of Midtdals-breen, a northern outlet of Hardangerjokulen southern Norway. The spatial and temporal pat-terns of water discharge, shapes of the dye-return curves, through-flow velocities, dye-recovery rates, dispersivities, and velocity/discharge rela-tionships suggest the existence of distinct catch-ments beneath the eastern and western halves of the glacier which are characterized by different types of drainage systems. Experiments on the eastern side were associated with high melt-water discharges and produced short-lived and highly

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peaked dye-return curves, fast through-flow velocities, high dye-recovery rates, low dispersivity values which decreased through the melt season, and a velocity/discharge relationship with an exponent of 1.0. Experiments on the western side were associated with low melt-water discharges and produced flat, extended dye-return curves which often displayed secondary peaks, slow through-flow velocities, low dye-recovery rates, high dispersivity values which increased during the melt season, and a velocity/discharge relationship with an exponent of 0.6. Comparison of observed through-flow velocities with values calculated theoretically using various hypothetical drainage-system structures suggests that water flows in a major sinuous conduit beneath the eastern half of the glacier and in a system of linked cavities beneath the western half. A model for the seasonal evolution of the whole drainage network is postulated which has important implications for temporal variations in subglacial water pressures and glacier-sliding velocity. (Author's abstract) W91-09945

IN-SITU TENSILE TESTS OF SNOW-PACK

Calgary Univ. (Alberta). Dept. of Civil Engineer-

ing.
J. B. Jamieson, and C. D. Johnston.
Journal of Glaciology JOGLAO, Vol. 36, No. 122,
p 102-106, 1990. 4 fig, 5 tab, 11 ref.

Descriptors: \*Avalanches, \*In situ tests, \*Snow-pack, \*Strength, Canada, Rocky Mountains, Testing procedures, Variation coefficient.

During the winter of 1987-88, an average of seven in-situ tensile tests was made for each of 66 snow layers in the Rocky Mountains of western Canada. The precision of the mean strength for seven tests, expressed in terms of the coefficient of variation, was 15% with 90% confidence. Snow with a faceted micro-structure was approximately half as strong as partly settled or rounded snow of the same density. Notch sensitivity in the strength data and critical strains of 1% or less indicate that the test fractures were essentially brittle. (Author's abstract)

#### GEOCHEMISTRY OF SOILS OF SPITSBER-GEN.

Moscow State-Lenin Pedagogical Institute. For primary bibliographic entry see Field 2G. W91-09947

# MODELING SNOWMELT-RUNOFF AND LAKE EVAPORATION USING SATELLITE DATA.

Brigham Young Univ., Provo, UT. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C. W91-10020

### WATER SURFACE PROFILES IN ICE COVERED RIVERS.

ERED RIVERS.

Michigan Technological Univ., Houghton. Dept. of Civil Engineering.

G. R. Alger, and H. S. Santeford.

In: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p E11-E17. 3 fig. 3 ref

Descriptors: \*Data interpretation, \*Ice cover, \*River ice, \*Rivers, \*Water surface profiles, Channel flow, Channels, Drawdown, Ice, Ice jams, Ice thickness, Mathematical analysis, Mathematical studies, Roughness coefficient, Upstream, Water level

Water surface profiles for ice covered rivers have been historically computed utilizing a variety of roughness ratios. A value of one, for example, is quite popular when utilizing Manning's equation. With this assumption one would conclude that for a wide shallow channel the under ice normal depth would be 1.32 times the free surface value. However, results obtained for both middlyman and different and depth.

er, results obtained for both uniform and drawdown reaches indicate that under ice depth and

open water depth are the same at the same discharge. This would suggest that water levels are only increased by submerged ice thickness. Results for slow down reaches indicate that water levels remain unchanged in the lower portion of the profile while upstream, the profile would become 'tilted' upward pivoting about the lower pool or reservoir level to a value equivalent to the free surface normal depth plus the submerged thickness of the ice. (See also W91-10018) (Author's abstract)
W91-10038

#### LARGE SCALE EFFECTS OF SEASONAL SNOW COVER.

Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. 425p. Edited by B. E. Goodison, R. G. Barry, and J. Dozier.

Descriptors: \*Climatology, \*Global warming, \*Snow, \*Snow cover, \*Snow surveys, Climates, Hydrology, International Commission on Snow and Ice, Remote sensing, Seasonal variation, Symposium.

Since 1980 the International Commission on Snow and Ice has promoted the review of the state of knowledge and research techniques applicable to the study of large areas covered with seasonal snow. One outcome of these efforts was an internasnow. One outcome of these efforts was an international symposium on large-scale effects of seasonal snow cover (SC), which was held during the 19th General Assembly of the International Union of Geodesy and Geophysics at Vancouver, British Columbia, Canada, 9-22 August 1987. This volume contains the proceedings of this symposium, which had three main thems: (1) role of SC in climate dynamics (polar and mid-latitude regions); (2) large-scale hydrologic effects of SC; and (3) remote sensing of SC. The specific topics covered include: SC as an indicator of climate change; SC—atmosshper; interactions parametrization of snow atmosphere interactions; parameterization of snow albedo for climate models; seasonal variation of Eurasian SC and its impact on the Indian summer monsoon; statistical studies of the atmospheric circulation of the northern hemisphere, hydroclimatic regimes in China, and Antarctic ice-SC; temporal and spatial variation of SC in the Swiss Alps; seasonal snow resources and their fluctuations in China; seasonal SC and temperature increase as factors in runoff; a method for indexing the variability of alpine seasonal snow over large areas; modeling large-scale effects of SC; snowmelt-runoff simulation model; use of computer-processed NOAA imagery for SC mapping and streamflow simulation; SC area as the main factor in forecasting snowmelt runoff from major river basins; operational airborne measurements of snow water equivalent and soil moisture; the influence of the variability of SC thickness on the intensity of water yield and duration of spring flood on a small river; a simple snowpack structure model; remote sensing of snow; interannual variations of snow melt on Arctic sea ice mapped from meteorologi-cal satellite imagery; estimating snowpack param-eters in the Colorado River basin; SC data in Germany; global SC and the earth's rotation; inte-gration of digital terrain models into ground-based now and runoff measurement; spatial estimation of snowpack variables from satellite data; snow extent snowpack variances from satellite data; snow extend and depth in Alaska; and bidirectional reflectance of snow at 500-600 nanometers. (See also W91-10339 thru W91-10373) (Rochester-PTT) W91-10338

#### LARGE-SCALE EFFECTS OF SEASONAL SNOW COVER.

Hilinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 2B.
W91-10339

#### SNOW COVER AS AN INDICATOR OF CLI-

Lamont-Doherty Geological Observatory, Palisades, NY.

saues, NY.

D. A. Robinson.

IN: Large Scale Effects of Seasonal Snow Cover.

Proceedings of an International Symposium held

August 9-22, 1987, Vancouver, British Columbia,

Canada. IAHS Publication 166, 1987. p 15-25, 5 fig. 3 tab, 21 ref. NSF Grant ATM 86-18676 and Air Force Office of Scientific Research Grant AFOSR 86-0053.

Descriptors: \*Climates, \*Climatology, \*Global warming, \*Snow, \*Snow cover, \*United States, Great Plains, Midwest, Precipitation, Regional analysis, Remote sensing, Satellite technology, Seasonal variation, Snow surveys, Spatial distribution, Temperature.

January snow cover in portions of the Midwest and Great Plains of the United States has shown significant variations during this century on year-to-year and long-term time frames. Over the past 40 yr, snow cover has increased in each region. This trend began in the late 1920s in the Plains, whereas in the Midwest the recent trend was pre-ceded by several decade-long oscillations. Snow cover data, including nearly complete records from 20 ground stations between 1901 and 1978 and weekly satellite-derived charts between 1967 and 1986 were employed in analysis. There is reasonable agreement between regional analyses made with each of the independent data sets for the 1967-1978 interval. There appears to be a positive relationship between colder and snowier-thanormal, and warmer-than-normal and relatively snow-free Januaries. Relationships between departures of snow cover and temperature and snow cover and precipitation have been suggested, but at this time it is impossible to fully confirm or specifically define the nature of these relationships. (See also W91-10338) (Author's abstract) W91-10340

#### SNOW COVER-ATMOSPHERIC INTERACTIONS.

Nebraska Univ., Lincoln. Dept. of Geography. For primary bibliographic entry see Field 2B. W91-10341

#### PARAMETERIZATION OF SNOW ALBEDO FOR CLIMATE MODELS.

Cooperative Inst. for Research in Environmental Science, Boulder, CO.
S. E. Marshall, and S. G. Warren.

S. E. Marshall, and S. G. warren.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 43-50, 5

Descriptors: \*Albedo, \*Climatology, \*General circulation models, \*Model studies, \*Snow, \*Snow cover, Optical properties, Parameterization, Physical properties, Snowpack, Solar zenith angle.

Results of general circulation models (GCMs) are sensitive to the assumed value of snow albedo. Snow albedo is highly variable and it is not calculated accurately in present-day GCMs. Most GCMs assign a single value to the albedo of an optically-thick snow cover. The albedo values range from 0.55 to 0.85 and generally remain constant with time until the snowpack decays to some critical depth, then decrease as a function of the snow depth until the albedo reaches the albedo of the underlying surface. Other GCMs allow the snow albedo to vary with solar zenith angle, snowpack thickness, age of the snow layer, and latitude. It would be advantageous to replace the current simple empirical parameterization of snow albedo with a physically-based parameterization, which is accurate and efficient to compute. Work on parameterization of snow surface albedo is still in progress. (See also W91-10338) (Author's abstract) W91-10342

# SEASONAL VARIATION OF EURASIAN SNOW COVER AND ITS IMPACT ON THE INDIAN SUMMER MONSOON.

Nairobi Univ. (Kenya). Dept. of Meteorology. O. S. R. U. Bhanu Kumar.

O. S. R. O. Bhanu Rumar. IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 51-60, 4

#### Group 2C-Snow, Ice, and Frost

fig. 2 tab. 19 ref.

Descriptors: \*Climatology, \*Europe, \*Asia, \*India, \*Monsoons, \*Snow, \*Snow cover, \*Snow surveys, Climates, Forecasting, Remote sensing, Satellite technology, Seasonal variation.

Seasonal variations of snow cover extent over Eurasia were derived from satellite data produced by the National Environmental Satellite Services for the period 1966-1985. Indian summer monsoon data were from the India Meteorological Department. Winter (December-March) and spring (March-May) snow cover areas exhibited increasing trends with time, but these were not significant. The influence of winter and spring snow cover extents on the dates of onset of monsoon over Kerala and total monsoon rainfall over India was noteworthy. The year-to-year variations of dates of onset of the phenomenon was negatively correlated with the Indian monsoon rainfall. These relationships with Eurasian winter snow cover extent are important input elements for developing long range forecasting of monsoon activity. (See also W91-10338) (Author's abstract) W91-10343

STATISTICAL STUDIES OF THE ATMOSPHERIC CIRCULATION OF THE NORTHERN HEMISPHERE, HYDROCLIMATIC REGIMES IN CHINA AND ANTARCTIC SNOW COVER. Academia Sinica, Beijing (China). Inst. of Geogra-

For primary bibliographic entry see Field 2B.

INTERACTIONS BETWEEN THE SNOW COVER AND THE ATMOSPHERIC CIRCULATIONS IN THE NORTHERN HEMISPHERE. Tsukuba Univ. (Japan). Inst. of Geoscience.

Y. Morinaga, and T. Yasunari. IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 73-78, 2

Descriptors: \*Atmospheric circulation, \*Climatic interactions, \*Climatology, \*Europe, Asia, \*Northern hemisphere, \*Snow, \*Snow cover, \*Snow surveys, Correlation analysis, North America, Remote sensing, Satellite technology, Seasonal distribution.

Hemispheric interactions between large-scale snow cover over the two continents (Eurasia and North America) and the atmospheric circulation in the northern hemisphere have been investigated for the period from November 1966 to December 1982. Lag correlations were computed between the extent of snow cover in central Asia and eastern North America and the 500 millibar geopotential height field in the northern hemisphere, using the NOAA/NESDIS Satellite Snow Cover data and 500 millibar geopotential height data. The snow cover-atmospheric height interactions are more hemispheric in central Asia than in eastern North America, with lags of more than a month. In hemispheric in central Asia than in eastern North America, with lags of more than a month. In eastern North America, concurrent correlation is prominent. Strong lag correlations are detected between February snow cover in central Asia and geopotential height anomalies in December, which has been specified by Wallace and Gutzler as the Eurasian pattern. February snow cover, in turn, has a considerable lingering effect on the atmos-phere in April. (See also W91-10338) (Author's abstract) abstract) W91-10345

TEMPORAL AND SPATIAL VARIATIONS OF THE SNOW COVER IN THE SWISS ALPS

Eidgenoessische Technische Hochschule, Zurich (Switzerland)

H. Lang, and M. Rohrer.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 79-92, 5 Descriptors: \*Alps, \*Snow, \*Snow cover, \*Switzerland, Climates, Frequency distribution, Hydrologic models, Mountain watersheds, Spatial varia-

The main characteristics of temporal and spatial snow depth and water equivalent distributions in the Swiss Alps were analyzed over the period from 1951 to 1980. Frequency distributions of the water equivalent on 1 April show significant differences for the various regions of the Alps, reflecting the corresponding climatic differences. This also is true for the temporal variations of the snow cover during single-winter accumulation periods and parourng single-winter accumulation periods and par-ticularly for single precipitation events. According to the synoptic weather processes, the large-scale development of the snow cover in the Alps shows large year-to-year variations. An attempt was made to analyze weather types together with the corresponding particular snow precipitation distri-bution. The results obtained encourage the use of the available synoptic meteorological information in large-scale snow cover modeling or even in the prediction of the impact of climatic variations on the occurrence and distribution of the alpine snow cover. (See also W91-10338) (Author's abstract)

SEASONAL SNOW RESOURCES AND THEIR FLUCTUATIONS IN CHINA.

Academia Sinica, Lanzhou (China). Lanzhou Inst. of Glaciology and Cryopedology.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 93-104, 8 fig. 11 ref.

Descriptors: \*China, \*Snow, \*Snow cover, \*Snow surveys, El Nino, Regional distribution, Seasonal variation, Southern oscillation, Spatial distribution, Tibetan plateau, Water resources

Based on data on daily depth and density of snow cover and snowfall recorded at more than 2,300 weather stations in China from 1951 to 1980, the snow resources were evaluated and their secular variations clarified. The mean annual snowfall recharge is 345.18 billion cu m, whereas the mean winter snow water storage and spring snowmelt runoff are 53.56 cu m and 23.57 cu m, respectively. runoit are 33.50 cm and 23.57 cu m, respectively. Snow resources display the following characteristics: poor but significant amount; uneven regional distribution; prominent seasonal and interannual variations; changeable storage throughout the winter; and monthly distribution contrary to the coldest months on the Tibetan plateau. The time series of snow resources revealed that they are consistent with the sea-level changes, temperature. consistent with the sea-level changes, temperature oscillations, and areal variation of farmlands in China that suffered from droughts. They also are in good agreement with the snow cover extent behavior of the northern hemisphere. The heavier snow appears to be associated with the El Nino-Southern Oscillation. (See also W91-10338) (Author's abstract) W91-10347

IMPORTANCE AND EFFECTS OF SEASONAL

SNOW COVER. Eidgenoessisches Inst. fuer Schnee- und Lawinenforschung, Davos (Switzerland).

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 107-120, 10 fig. 2 tab. 28 ref.

Descriptors: \*Runoff forecasting, \*Seasonal distri-bution, \*Snow, \*Snow cover, \*Snow surveys, \*Streamflow forecasting, Data acquisition, Map-ping, Northern hemisphere, Remote sensing, Re-search priorities, Water resources.

Despite the impressive volume of ice on the earth, the seasonal snow cover is more important, par-ticularly in industrialized countries of the northern hemisphere. Measurements of the occurrence, depth, and water equivalent of snow are done

regularly, but need further improvement, especialregularly, but need further improvement, especially for operational river flow forecasts. Systematic gathering of snow data in established centers facilitates their use and the evaluation of return periods of extreme events. Efficient large-scale monitoring of seasonal snow cover becomes possible by the increasing application of remote sensing from satellites. Remote sensing already has improved the evaluation of the areal extent of the seasonal snow cover on basin-, continental-, and world scale. The main task remaining is the development of truly operational periodic snow cover mapping on a large scale, complemented by evaluations of the water equivalent. Better data favor the use of modeling for runoff forecasting and evaluation of the hydrological effects of possible climate changes. Improved acquisition of snow data must be accompanied by an adequate development of all applications to achieve a favorable cost-benefit balance. (See also W91-10338) (Rochester-PTT) W91-10348

LARGE SCALE EFFECTS OF SEASONAL SNOW COVER AND TEMPERATURE INCREASE ON RUNOFF.

Agricultural Research Service, Beltsville, MD. Hydrology Lab. For primary bibliographic entry see Field 2B. W91-10349

ESTIMATES OF POSSIBLE VARIATIONS OF SNOWMELT-RUNOFF CHARACTERISTICS AND CLIMATIC CHANGES.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem. For primary bibliographic entry see Field 2B.

W91-10350

METHOD OF INDEXING THE VARIABILITY OF ALPINE SEASONAL SNOW OVER LARGE AREAS.

Otago Univ., Dunedin (New Zealand). Dept. of

Geography. B. B. Fitzharris

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 139-150, 6 fig. 2 tab. 17 ref.

Descriptors: \*Alps, \*Mountain watersheds, \*Runoff forecasting, \*Snow, \*Snow cover, \*Snow storage index, \*Snow surveys, \*Streamflow forecasting, New Zealand, Performance evaluation, Precipitation, Seasonal distribution, Temperature.

Assessing the size of the seasonal snow cover requires not so much estimates of the absolute quantity of water stored as snow, but a measure of its variability from a long-term average. Over large areas of the alpine world there are no snow courses to make these assessments, so alternative methods must be found. A technique was developed for estimating the relative size of seasonal snow cover using climate station data from lowland sites. A snow storage index was derived using weekly departures from the average of precipitation and temperature recorded at 21 climate stations adjacent to the mountain areas of the South Island of New Zealand. Data for each climate station was weighted according to how well it represents eco-nomically important river basins that flow into large hydroelectric storage lakes. Based on perlarge hydroelectric storage lakes. Dased on per-formance over eight winters, the technique shows promise for operational use. The technique capital-izes on long-term information contained within records of climate station observations, and provides near real-time assessments as the snowpa evolves during winter and spring. It can be implemented for any alpine area with surrounding climate stations, provided the variability of their temperature and precipitation observations represents that experienced in the mountains. (See also W91-10338) (Rochester-PTT) W91-10351

MODELLING LARGE SCALE EFFECTS OF SNOW COVER.

#### Snow, Ice, and Frost-Group 2C

British Columbia Univ. Vancouver. For primary bibliographic entry see Field 2B. W91-10352

SNOWMELT-RUNOFF SIMULATION MODEL OF A CENTRAL CHILE ANDEAN BASIN WITH RELEVANT OROGRAPHIC EFFECTS. Direccion General de Aguas, Santiago (Chile).

H. Pena, and B. Nazarala.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 161-172, 7 fig. 4 tab. 5 ref.

Descriptors: \*Chile, \*Model studies, \*Mountain watersheds, \*Runoff, \*Runoff forecasting, \*Snow, \*Snowmelt, \*Streamflow forecasting, Andes, Glacial streams, Hydrologic models, Maipo River, Mathematical models, Simulation analysis.

Meltwater from snow and ice in the Andes range is the most important water resource in the central area of Chile. A snowmelt-runoff simulation model of the upper Maipo River basin in the Andean highlands of central Chile was developed. Empiri-cal relations developed for the area were used to compute the snow and ice melt. The influence of the spatial structure of the model and the redistributton of snow falling on high-slope surfaces were considered. The role of semi-perennial snow cov-ered areas and the runoff from glaciers was empha-sized. Although the runoff from glaciers is small in relation to total discharge, their contribution significant during dry years at the end of the summer period (e.g., 34% in February 1982). This runoff from glaciers comprised up to 67% of the monthly discharge measured during the driest summer recorded on the Maipo River (1968/1969). (See also W91-10338) (Rochester-PTT) W91-10353

#### UTILITY OF COMPUTER-PROCESSED NOAA IMAGERY FOR SNOW COVER MAPPING AN STREAMFLOW SIMULATION IN ALBERTA.

Alberta Environment, Edmonton. S. Ferner, and I. Sutherland.

IN: Large Scale Effects of Seasonal Snow Cover. IN: Large Scale Effects of Seasonal Show Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 173-185, 16

Descriptors: \*Alberta, \*Hydrologic models, \*Model studies, \*Remote sensing, \*Runoff forecasting, \*Snow, \*Snow cover, \*Streamflow forecasting, Mapping, Mountain watersheds, Runoff, Satellite technology, Simulation, Streamflow, Streamflow Synthesis and Reservoir Regul.

Computer processed NOAA satellite imagery for the large (2200 sq km) mountainous basin of Alberta was found to be useful for snowmelt modeling using the SSARR (Streamflow Synthesis and Reservoir Regulation) model in 1985 and 1986. The percent snow covered area (SCA) versus percent snow water equivalent (SWE) relationship used in the snowmelt routine of the model was defined by forcing the model to use NOAA SCA estimates. The percent SCA versus percent SWE curves differed markedly between the two years modeled, and the results suggest that a family of curves with initial SWE as the third parameter will improve simulation results. SCA statistics were generated for a series of cloud-free dates in each year by a tor a series of conductive dates in early leaf by a one-dimensional thresholding of channel 2 (near infrared) data. A technique for correcting the illu-mination of images with a lower solar angle was developed. The modified version of the SSARR developed. The modified version of the SSARR model is useful for defining the percent SCA versus percent SWE relationship within a limited range of SCA (20-55%). The specification of snow cover depletion curves to SSARR, with initial SWE as a third parameter, permits a better simulation result than that achieved through the use of an average (single) snow cover depletion curve. (See also W91-10338) (Author's abstract) W91-10354

SNOW COVER AREA (SCA) IS THE MAIN FACTOR IN FORECASTING SNOWMELT RUNOFF FROM MAJOR RIVER BASINS. National Remote Sensing Agency, Hyderabad (India). Hydrology Div.

A. S. Ramamoorthi.
IN: Large Scale Effects of Seasonal Snow Cover. IN: Large Scale Effects of Seasonal State Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 187-198, 3

Descriptors: \*India, \*Model studies, \*Runoff, \*Runoff forecasting, \*Snow, \*Snow cover, \*Snowmelt, \*Streamflow forecasting, Catchment areas, Developing countries, Forecasting, Hydrologic models, Mountain watersheds, Remote sensing. Sutlei River.

In developing countries like India, the forecasting of snowmelt runoff, both seasonal and short-term, is vital for the optimum development of the summer flows for power generation, irrigation, and drinking water supply. Most snowmelt runoff models developed in Europe and the United States relate to small catchments and they are simulation models. With the advent of satellite remote sensing technology in India, especially the availability of NOAA satellite data, it became possible to attempt snowmelt runoff studies. From a study of the Sutley River basin above Bhakra (catchment area Sutley River basin above Bhakra (catchment area 43,230 sq km) a regression model was developed using percentage of snow covered area and seasonal snowmelt runoff to forecast the runoff during the four years 1980-1983. The forecast quantities varied from the measured discharges at Bhakra by less than 10%. Efforts also were made to examine the effect of temperature in addition to snow covered area in the Sutlej basin. The effect of temperature on the variation of seasonal snowmelt runoff from year to year will not be significant because from year to year will not be significant occasions changes in temperature during the different years in the snowmelt runoff period are not significant. Thus, snow covered area is the main factor in forecasting snowmelt runoff of major mountainous river basins like the Sutlej River basin. (See also W91-10338) (Author's abstract) W91-10355

MODELLING OF SNOWMELT DISTRIBUTION FOR THE ESTIMATION OF BASINWIDE SNOWMELT USING SNOW COVERED

AREA.
Tokyo Univ. (Japan). Dept. of Civil Engineering.
T. Koike, Y. Takahasi, and S. Yosino.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. 1AHS Publication 166, 1987. p 199-212, 15

Descriptors: \*Hydrologic models, \*Japan, \*Model studies, \*Runoff forecasting, \*Snow cover, \*Snow surveys, \*Snowmelt, \*Streamflow forecasting, Air temperature, Forest watersheds, Insolation, Landsat images, Mathematical models, Performance evaluation, Precipitation, Remote sensing, Satellite technology, Slopes.

Information on snow covered area derived from remote sensing is available for estimation of basin-wide snowmelt. It is necessary to clearly identify the distribution of snowmelt in order to estimate basin-wide snowmelt precisely using snow covered area data obtained through the Landsat multispectral scanner and NOAA AVHRR. A model was developed for the estimation of snowmelt distribution that is based on meteorological observations and snow surveying in the Syozawa basin, Japan. The model includes net radiation, degree-hour approach, and a combination of condensation and evaporation applicable for rainy days. First the observational base, which is a flat and open area, was modeled using insolation, air temperature, and precipitation. The result of this application agreed well with observed data. Second, the model was applied to slopes and forested areas. For slopes, air temperature was decreased with elevation and insolation was corrected by the insolation receiving rate of the slopes. For the forested areas, insolation was corrected by the forest canopy cover rate. In both cases, the model results agreed well with the

observed data. It is concluded that this model for snowmelt at the base can be applied to any site covered with snow in the basin by correcting insolation and air temperature according to topographic characteristics. (See also W91-10338) (Author's abstract) observed data. It is concluded that this model for thor's abstract) W91-10356

OPERATIONAL AIRBORNE MEASURE-MENTS OF SNOW WATER EQUIVALENT AND SOIL MOISTURE USING TERRESTRIAL GAMMA RADIATION IN THE UNITED

National Weather Service, Minneapolis, MN. Office of Hydrology. T. R. Carroll.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 213-223, 2

Descriptors: \*Canada, \*Gamma radiation, \*Remote sensing, \*Snow cover, \*United States, Data acquisition, Error analysis, Forecasting, Iso-

The National Weather Service (NWS, USA) maintains an Airborne Gamma Radiation Snow Survey Program to make operational, real-time snow water equivalent and soil moisture measurements over a network of 1250 flight lines covering por-tions of 23 states and 5 Canadian provinces. The Airborne Program provides airborne snow and soil measurements to hydrologists in the NWS and other federal and states agencies. The real-time data are used operationally by the NWS hydrologists when issuing river and flood forecasts, water supply forecasts, and spring flood outlooks for large areas of the country. Airborne snow water equivalent measurements typically are made over agricultural areas with a root mean square error of 8 mm and over forested areas with a root mean square error of 23 mm water equivalent. (See also W91-10338) (Author's abstract) W91-10357

DETERMINATION OF WATER EQUIVALENT OF SNOW AND THE FORECAST OF SNOW-MELT RUNOFF BY MEANS OF ISOTOPES IN

State Hydraulic Works, Ankara (Turkey). Techni-cal Research and Quality Control Dept. I. Ertan.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 225-239, 13 fig. 10 ref.

Descriptors: \*Gamma radiation, \*Instrumentation, \*Isotope studies, \*Runoff, \*Snow cover, \*Snow-melt, \*Snowpack, \*Turkey, Hydrographs, Performance evaluation, Regression analysis.

For the first time in Turkey, water equivalent of snow pack and runoff were determined, respectivesnow pack and runoff were determined, respective-ly, by the absorption of gamma radiation passing through a snowpack and the environmental iso-tope. Regression equations for the snow depth and water equivalent of snow were determined by using both the nuclear and the classical techniques. A good relation between the flow hydrograph and A good relation between the now hydrogaph and the 180 standard mean ocean water (\$MOW) values was observed. By using the flow hydro-graph and the environmental isotope content of water samples, the subsurface flow hydrograph and the surface flow hydrograph were determined using nuclear techniques. Use of these research methods resulted in exact values. The nuclear techniques are to the nuclear techniques are to the nuclear techniques. niques can be applied alone or in combination with classical techniques. (See also W91-10338) (Author's abstract) W91-10358

MODELLING THE EFFECTS OF AGROTECH-NICAL MEASURES ON SPRING RUNOFF AND WATER EROSION.

#### Field 2—WATER CYCLE

#### Group 2C—Snow, Ice, and Frost

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem

Y. G. Motovilov IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium hald Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 241-251, 3

Descriptors: \*Agricultural runoff, \*Erosion, \*Hydrologic models, \*Model studies, \*Runoff, \*Runoff forecasting, \*Snow cover, \*Snowmelt, \*Soviet Union, \*Streamflow forecasting, Cultivation, Infiltration, Mathematical models, Permeability.

Intensive development of physically based models to describe the hydrologic cycle has been stimulated recently by the need to estimate anthropogenic influences on vital river basin parameters. A mathematical model was developed of snowmelt runoff formation in a basin. During model development hydrothermal regime of snow and soil, overland flow, and suborid effects were considered. The flow, and subgrid effects were considered. model was tested in the Trud River basin, USSR (1130 sq km). A series of numerical experiments were conducted with and without accounting for subgrid effects. The model then was applied to the whole basin of the Sosna River (16,300 sq km), where there were 200 elements and 7 tributaries in the channel network in addition to the main channel. Subsequently, numerical experiments were conducted where the water regulating role of various cultivation techniques was evaluated using the mathematical model. Differences in soil infiltration properties under different conditions were not as properties under different conditions were not as important in meltwater runoff formation as changes in surface retention storage, which was related to depth of freezing and pre-spring soil moistening. Finally, the calculated spring runoff results were employed in studies of soil losses under different conditions of cultivation. Fields occupied by perennial herbs had strong counteroccupied by periminal nerve and strong counter-erosion properties, which were diminished by fall plowing. Loss of soil particles was greater in the northern part of the basin because the maximum snow storage values and depth of freezing of the sol are greater in the north, leading to decreased soil permeability during snow melting, an increase in the surface flow layer, and greater washing off of soil particles. (See also W91-10338) (Rochester-PTT) W91-10359

INFLUENCE OF THE VARIABILITY OF SNOW COVER THICKNESS ON THE INTEN-SITY OF WATER YIELD AND DURATION OF SPRING FLOOD ON A SMALL RIVER, Gosudarstvennyi Gidrologicheskii Inst., Leningrad (1989).

For primary bibliographic entry see Field 2A. W91-10360

(USSR).

SIMPLE SNOWPACK STRUCTURE MODEL AND ITS APPLICATION TO MOUNTAIN SNOWPACK PROBLEMS.

California State Univ.-San Bernadino. Dept. of Geography.

In: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 265-275, 9 fig. 13 ref.

Descriptors: \*Colorado, \*Computer models, \*Model studies, \*Snow, \*Snowpack, \*Snowpack structure, Microcomputers, Performance evaluation, SNOMOD model, Seasonal distribution, Sim-

Simulation models that address the complete structure of a seasonal snow cover are not common, and existing models are large. Design of a simple existing models are large. Design of a simple microcomputer-based snowpack model was undertaken as part of a study investigating seasonal snow cover in Colorado. Version 3.4 of the SNOMOD model is designed to be run interactively and is menu driven. The operator can select routines that allow for easy parameter adjustment and inclusion of a pre-existing snowpack. The final input option permits the entry of air temperature, new snow

depth, and new snow density over the time period of the model run along with input time steps and the number of terms used in the temperature smoothing routine. Calibration runs of the model duplicated reasonably the observed stratigraphy at a level study plot. Subsequent runs of the model indicate that it may be useful for extrapolating estimates of snowpack conditions over a localized range of elevations and aspects. (See also W91-10338) (Rochester-PTT) W91-10361

REMOTE SENSING OF SNOW.

Innsbruck Univ. (Austria). Inst. fuer Meteorologie und Geophysik. H. Rott.

In: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 279-290, 3 fig, 1 tab, 40 ref.

Descriptors: \*Literature review, \*Remote sensing, \*Satellite technology, \*Snow, \*Snow cover, Cli-mates, Forecasting, Landsat images, Microwave sensors, Monitoring, Radar, Snowmelt.

Remote sensing methods enable efficient monitor-ing of snow cover from the regional to the global . Reflection and emission signatures of are described in the microwave and optical parts of the spectrum and depend on various parameters. Satellite images in the visible and near infrared are employed for mapping the areal extent of snow. These data are a valuable base for climate studies and are used operationally for snowmelt runoff forecasting. Investigations with spaceborne microtorecasting. Investigations with spaceborne micro-wave radiometer data demonstrate the capabilities for all-weather mapping of snow areal extent and water equivalent and for detecting the onset of snowmelt. The main drawback of passive micro-wave sensors (limited spatial resolution) can be overcome with active sensors. Synthetic aperture overcome with active sensors. Symmetry aperture radars can detect wet snow cover and provide high spatial resolution. A significant number of microwave sensors will be launched during the control decade but increased research efforts will be next decade, but increased research efforts will be needed to use this potential. (See also W91-10338) (Author's abstract) W91-10362

DISCUSSION OF THE ACCURACY OF NOAA SATELLITE-DERIVED GLOBAL SEASONAL SNOW COVER MEASUREMENTS.

Satellite Hydrology, Inc., Vienna, VA.
D. R. Wiesnet, C. F. Ropelewski, G. J. Kukla, and D. A. Robinson.

IN: Large Scale Effects of Seasonal Snow Cover. INV. Large Scare Effects of Seasonal Show Cover-Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 291-304, 7 fig. 2 tab, 11 ref. ATM 85-05558.

Descriptors: \*Remote sensing, \*Satellite technology, \*Snow, \*Snow cover, Climates, Comparison studies, Data acquisition, Northern hemisphere, Performance evaluation, Snow depth, Spatial distribution, Temporal distribution.

The first weekly charting of snow cover in the northern hemisphere using meteorological satellite images was begun by NOAA in November 1966. While this long-term data base is a significant improvement over ground charts produced solely from ground station data, several real and potential sources of error affect it. Because climatologists who study the effect of large-scale snow cover on the global heat budget use these data, evaluation of their accuracy is appropriate. Investigations were conducted in an attempt to quantify the noise level in the data. It was concluded that, except for the fall season, the data are accurate enough for climate-related studies on continental or hemispheric scales. However, care should be exercised and additional verification with station data is recommended before using the product in local or re-gional studies of snow cover variation. Research should be oriented toward the integration of satellite information with conventional meteorological station data. In this way, a much greater spatial and temporal precision could be achieved and

snow depths could be included in the charts. Research into microwave satellite sensors should be intensified to assist in the collection of data on snow depth and snow water equivalent as well as the distribution of melting snow cover. (See also W91-10338) (Rochester-PTT) W91-10363

REMOTE SENSING OF SNOW CHARACTER-IN THE SOUTHERN NEVADA.

California Univ., Santa Barbara. Cent Remote Sensing and Environmental Optics. Center for J. Dozier.

IN: Large Scale Effects of Seasonal Snow Cover Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 305-314, 5 fig. 1 tab, 21 ref.

Descriptors: \*California, \*Remote sensing, \*Satel-lite technology, \*Snow, \*Snow cover, Albedo, Data acquisition, Digital map data, Mountain wa-tersheds, Optical properties, Sierra Nevada, Simu-

Estimation of snow characteristics from satellite remote sensing data requires that snow be distinguished from other surface cover and from clouds, that compensation be made for the effects of the atmosphere and rugged terrain, and that snow albedo be interpolated over the entire spectrum based on measurements from only a few wavelengths. It also is necessary to account for topographic effects without requiring that satellite data be precisely registered to digital elevation data, because the poor quality of most digital elevation data introduces considerable noise into calculations of slope and azimuth. The key to interpretation of satellite-measured snow reflectances in alpine tersatellite-measured snow reflectances in alpine ter-rain lies first in simulation of a variety of condi-tions using an atmospheric radiation model cou-pled to a lower boundary condition that depends on topography and on snow grain characteristics. From simulation of a range of snow types and various atmospheric profiles over all possible illu-mination conditions it is possible to develop typical spectral signatures above the atmosphere over mountainous terrain. These permit the separation of several classes of snow from other surface of several classes of snow from other surface covers, even though snow in the shadows is darker than snow in sunlight. In particular, snow can be discriminated from rocks, bare soil, and vegetation over snow. Snow also can be classified on the basis of grain size and amount of contamination. Thick clouds are distinguished easily from snow and thin clouds over snow can be distinguished from thin clouds over soil. (See also W91-10338) (Rochester-W91-10364

ANALYSIS OF INTERANNUAL VARIATIONS OF SNOW MELT ON ARCTIC SEA ICE MAPPED FROM METEOROLOGICAL SATEL-LITE IMAGERY.

Lamont-Doherty Geological Observatory, Palisades, NY.

D. A. Robinson, G. Scharfen, R. G. Barry, and G.

IN: Large Scale Effects of Seasonal Snow Cover. IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p. 315-327, 6 fig. 2 tab. 27 ref. NSF Grant ATM 83-18676, Air Force Office of Scientific Research Grant AFOSR86-0053, and Office of Naval Research N00014-86-K-0695 (subcontract 5-36378).

Descriptors: \*Arctic, \*Remote sensing, \*Satellite technology, \*Sea ice, \*Snow, \*Snowmelt, Air temperature, Albedo, Cloud cover, Interannual variation, Mapping, Seasonal distribution, Time series

The seasonal progression of snow melt on the Arctic ice pack was mapped from shortwave satellite imagery for 1977, 1979, 1984, and 1985. The four years showed differences in the timing of the melt interval. The progression of melt in May and June of the year with the earliest melt (1977) was 3

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wk ahead of that of the year with the latest melt (1979). As a result, basin-wide surface albedo varied by upwards of 0.08 in June, ranging from 0.58 in 1977 to 0.66 in 1979. May and July showed interannual variations in albedo of up to 0.05. The country of the property interannual variations in abord or up to 0.05. In extent of snow melt varied from year to year in the central Arctic. The region was essentially snow free by mid-July in 1977 and 1979, but retained some snow throughout the summer in 1984 and for all but 2 wk in 1985. Although limited in extent, the exceeded data base suggests relationships by the present data base suggests relationships be-tween snow melt and Arctic surface air tempera-tures in spring, spring cloudiness, and the extent of late summer ice. (See also W91-10338) (Author's abstract) W91-10365

SNOW MELT ON SEA ICE SURFACES AS DE-TERMINED FROM PASSIVE MICROWAVE

SATELLITE DATA.
Scripps Institution of Oceanography, La Jolla, CA.
M. R. Anderson.
IN: Large Scale Effects of Seasonal Snow Cover.

nv: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 329-342, 6 fig, 13 ref. NASA Ocean Programs Grant NAGW-1028.

Descriptors: \*Arctic, \*Remote sensing, \*Satellite technology, \*Sea ice, \*Snowmelt, Barents Sea, Chukchi Sea, East Siberian Sea, Energy, Kara Sea, Laptev Sea, Scanning multichannel microwave radiomet, Temperature, Time series analysis.

Scanning Multichannel Microwave Radiometer (SMMR) data for the years 1979, 1980, and 1984 were analyzed to determine the variability in the were analyzed to determine the variationly in the onset of melt for the Arctic seasonal sea ice zone. The results show melt commencing in either the Kara/Barents Seas or Chukchi Sea and progressing zonally towards the central Asian coast (Laptev Sea). Individual regions had interannual variations in melt onset in the 10-20 day range. To determine whether daily changes occur in the sea ice surface melt, the SMMR 18-GHz and 37-GHz brightness temperature data were analyzed at day/ night/twilight periods. Brightness temperatures il-lustrate diurnal variations in most regions during melt. In the East Siberian Sea, however, daily variations were observed in 1979, throughout the analysis period, well before any melt usually would have commenced. Understanding microwave re-sponses to changing surface conditions during melt perhaps will provide additional information about energy budgets during the winter-to-summer transition of sea ice. (See also W91-10338) (Author's abstract) W91-10366

ESTIMATING SNOWPACK PARAMETERS IN THE COLORADO RIVER BASIN.

THE COLORADO RIVER BASIN.

National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
A. T. C. Chang, J. L. Foster, P. Gloersen, W. J.
Campbell, and E. G. Josberger.

IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. IAHS Publication 166, 1987. p 343-352, 3
fig. 1 toh. 11 cef fig. 1 tab. 11 ref.

Descriptors: \*Colorado River Basin, \*Remote sensing, \*Runoff forecasting, \*Snow surveys, \*Snowmelt, \*Snowmelt forecasting, \*Snowpack, Algorithms, Data processing, Forecasting, Mountain watersheds, Performance evaluation, Runoff, Satellite technology, Scanning multichannel micro-

Melting snow provides over 70% of the water supply for the western United States. Flooding in the Colorado River basin during the spring and early summer of 1983 led to the recognition of the need for better estimates of snowmelt runoff from the high elevation watersheds that contribute most of the swelf for the Colorado Piura Invested runoff for the Colorado River. Improved knowledge of the snow water storage over the entire basin should improve forecasts of spring runoff and allow better management of the water resources. Passive microwave remote sensors can

penetrate the snowpack and respond to variations in snowpack properties, thereby providing infor-mation about depth and water equivalent of the snowpack. Scanning Multichannel Microwave Ra-diometer data for five winter seasons from 1978 to 1983 were studied to see if a relationship could be established between microwave brightness temestablished between microwave brighniess tem-peratures and snow depth measurements made in different elevation zones and physiographic areas of the Colorado River basin. Three years of data are being employed to develop a snow parameter retrieval algorithm, which will be tested by using the remaining 2 yr of data. Preliminary results indicate that even in heterogeneous mountain re-gions it may be possible to use remotely sensed microwave data to better estimate the water equiv-alent of high elevation snowpacks. (See also W91-10338) (Author's abstract) W91-10367

SNOW COVER PARAMETER RETRIEVAL FROM VARIOUS DATA SOURCES IN THE FEDERAL REPUBLIC OF GERMANY.

Cooperative Inst. for Research in Environmental Science, Boulder, CO.

A. J. Schweiger, R. Armstrong, and R. G. Barry. IN: Large Scale Effects of Seasonal Snow Cover Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 353-364, 12 fig, 12 ref. NSF Grant SES 8518586.

Descriptors: \*Germany, \*Remote sensing, \*Snow, \*Snow cover, Algorithms, Data processing, Performance evaluation, Satellite technology, Scanning multichannel microwave radiomet, Snow

The effect of snow on the radiative energy budget has received attention from climatologists and weather forecasters. Climate models usually predict snow in the form of water equivalent. Snow dict snow in the form of water equivalent. Snow depth and water equivalent point measurements from 60 synoptic stations in West Germany were gridded and contoured for two seasons (1978/1979, 1979/1980). These maps were compared to the results of a simple snow extent algorithm based on brightness temperature data from the Scanning Multichannel Microwave Radiometer (SMMR). Visible band Defense Meteorological Satellite Program imagery as well as NOAA/NESDIS snow charts were employed for comparison. The results indicate that snow extent mapping using micro-wave satellite data is possible. However, several specific problems arise from the incompatibility of correlative data. The development of a reliable snow depth algorithm requires research in the folsnow depth algorithm requires research in the fol-lowing main areas: (1) development of ground measurement data bases permitting a direct pixel-to-pixel comparison with SMMR brightness tem-peratures; (2) effects of terrain, vegetation, and other surface factors, particularly the mixed-pixel problem; and (3) additional study of the theory of microwave emission from snowpack. (See also W91-10338) (Rochester-PTT) W91-10368

GLOBAL SNOW COVER AND THE EARTH'S ROTATION.

National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch. J. L. Foster, D. K. Hall, A. T. C. Chang, B. F. Chao, and W. P. O'Connor.

IN: Large Scale Effects of Seasonal Snow Cover. 10: Large Scale Effects of Seasonal Show Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 365-374, 1 fig, 13 ref.

Descriptors: \*Earths rotation, \*Geophysics, \*Rotational perturbations, \*Snow, \*Snow cover, Algorithms, Remote sensing, Satellite technology, Scanning multichannel microwave radiomet, Snow depth.

The motion of the Earth's rotation with respect to the geographic reference frame, known as the polar motion, consists mainly of an annual wobble and a 14-month wobble called the 'Chandler wobble.' The annual wobble is a forced motion caused by seasonal changes in the Earth's atmos-

phere and hydrosphere. Snow has a certain contri-bution to the annual wobble, but the extent of its contribution is unknown. Until recently monthly measurements of global snow volume were too inexact to be able to determine the effect of snow on the Earth's rotation. However, with the launch of the Nimbus satellite in 1978, with its Scanning Multichannel Microwave Radiometer (SMMR) in-strument, which is capable of measuring snow cover and estimating snow depth, it is now possible to assess and monitor changes in the distribution of snow mass on the Earth's surface. Preliminary results indicate that an algorithm derived for deducing global snow depth over land from SMMR signal is sufficiently reliable to measure the effects signal is sufficiently reliable to measure the effects of snow mass on polar motion. It has been found that the snow load excitation has an amplitude that is some 30% of the total annual wobble excitation, thus representing a significant geophysical contribution. (See also W91-10338) (Author's abstract)

INTEGRATION OF DIGITAL TERRAIN MODELS INTO GROUND BASED SNOW AND RUNOFF MEASUREMENT.

Saskatchewan Research Council, Saskatoon J. Whiting, and J. Kiss.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 375-387, 6 fig. 3 tab. 3 ref.

Descriptors: "Canada, "Digital terrain models, "Model studies, "Runoff, "Runoff forecasting, "Snow cover, "Snowmelt, "Streamflow forecasting, Aerial photography, Big Quill Lake, Catchment areas, Hydrologic budget, Performance evaluation, Satellite technology, Seasonal distribution,

The study of digital terrain models (DTM) was conducted at Big Quill Lake, Canada. The Wynyard Watershed with the basin was established as a research basin to increase the accuracy of runoff estimation. Aerial photography and satellite data were used to delineate the active part of the waterwere used to defendate the active part of the water-shed from the depression-storage areas. An aerial photographically-derived DTM was used to give channel volume, global and local catchment, dis-persal area, and slope aspect. In Prairie watersheds the runoff behavior is influenced by the frequency components of snow distribution such as land use and topography, and stochastic meteorological events such as spring storms. The DTM model was used to refine the snow course network. The snow course sites were placed such that each site represented an equal volume of channel. A random sented an equal volume of channel. A random distribution of snow sites showed a bias to the flatter third of the basin. The DTM showed that a significant portion (38%) of the total runoff from snow already was in the channels before spring runoff began. The use of the DTM model increased the accuracy of the spring and annual water budget estimations of Big Quill Lake. (See also W91-10338) (Author's abstract) W91-10370

CLASSIFICATION MODEL OF SPATIAL ESTI-MATION OF SNOWPACK VARIABLES FROM SATELLITE DATA.

Utah State Univ., Logan. R. W. Gunderson, C. H. Leu, D. S. Bowles, and J. P. Riley.

IN: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 389-401, 6 fig, 14 ref.

Descriptors: \*Classification, \*Landsat images, \*Model studies, \*Remote sensing, \*Satellite technology, \*Snowpack, Algorithms, Digital elevation models, Mapping, Multivariate analysis, Pattern recognition, Spatial distribution, Topography.

Multispectral electromagnetic radiation data, collected by remote sensing platforms such as Land-sat, have received considerable attention as a way to account for variability in watershed snowpack

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conditions. A new approach to spatial modeling of snowpack variables has been devised that combines new developments from the theory of pattern rec-ognition and multivariate data analysis with: (1) ognition and multivariate data analysis with: (1) multispectral measurements made from operational satellites; (2) readily available topographic information from digital elevation models (DEMs); and (3) easily obtainable ground snowpack measurements obtained at a few optimally selected sites. Unsupervised disjoint principal component modeling was employed using fuzzy C-varieties algorithms and the resulting model was tested at Dry Lake watershed (southern Utah). Early results show that for randomly located points on the Lake watershed (southern Utah). Early results show that for randomly located points on the watershed the predicted values of snow water equivalent and depth are within 5-10% of the measured values. The proposed methodology offers the potential for a compact representation of spatially distributed hydrologic state variables such as those associated with a snowpack. It is readily applicable because of the availability of Landsat thematic mapper data and DEMs, and because of the automated nature of the classification algorithms. The full potential of this methodology for rithms. The full potential of this methodology for hydrologic applications is being evaluated. (See also W91-10338) (Rochester-PTT) W91-10371

DISTRIBUTION OF SNOW EXTENT AND DEPTH IN ALASKA AS DETERMINED FROM NIMBUS-7 SMMR MAPS (1982-83).

NIMBUS-7 SMMR MAPS (1982-83).
National Aeronautics and Space Administration,
Greenbelt, MD. Hydrological Sciences Branch.
D. K. Hall, A. T. C. Chang, and J. L. Foster.
IN: Large Scale Effects of Seasonal Snow Cover.
Proceedings of an International Symposium held
August 9-22, 1987, Vancouver, British Columbia,
Canada. IAHS Publication 166, 1987. p 403-413, 1 fig. 2 tab, 22 ref, 3 pl.

Descriptors: \*Alaska, \*Remote sensing, \*Satellite technology, \*Snow cover, \*Snow depth, \*Snow surveys, \*Algorithms, Hoar frost, Maps, Radio-metry, Scanning multichannel microwave radio-

Scanning Multichannel Microwave Radiometer (SMMR) maps of Alaska for October 1982 through May 1983 have been obtained that show snow conditions as determined using an algorithm that employs SMMR data to calculate snow depth in 1/2 degree latitude by 1/2 degree longitude grid blocks. An idealized snowpack having a uniform snow grain radius (0.35 mm) and density (300 kg per cu m) was assumed to produce a snow depth snow grain radius (0.35 mm) and density (300 kg per cu m) was assumed to produce a snow depth map for the northern hemisphere. Large-scale snow build-up and dissipation patterns are observable. By mid-November, SMMR-derived snow depths are much higher than measured snow depths (approx 24 cm vs 13 cm, respectively) over much of northern Alaska. This probably is due to the depth hoar that forms at the base of the snow-packs and causes a reduction in the brightness temperature Tb resulting from the large (up to 1 cm) hoar crystals. Despite heavy forest cover in central Alaska, in mid-February the measured snow depth in Fairbanks (58 cm) corresponds quite well with SMMR-derived snow depth (36-51 cm). The coefficient of correlation (R) between snow The coefficient of correlation (R) between snow depth and 37-GHz microwave Tb is -0.70, -0.50, and -0.71 in selected areas in northern, central, and and 40.7 in selected areas in northern, central, and southern Alaska, respectively. Algorithms that are designed for snow conditions that differ from the idealized snowpack need to be developed for areas such as northern and interior Alaska to obtained improved estimates of snow depth. (See also W91-10338) (Author's abstract) W91-10372

#### BIDIRECTIONAL REFLECTANCE OF SNOW AT 500-600 NM.

Cooperative Inst. for Research in Environmental Science, Boulder, CO.

K. Steffen. N. Sterten. III: Large Scale Effects of Seasonal Snow Cover. Proceedings of an International Symposium held August 9-22, 1987, Vancouver, British Columbia, Canada. IAHS Publication 166, 1987. p 415-425, 5 fig. 1 tab. 11 ref.

Descriptors: \*Albedo, \*Optical properties, \*Reflectance, \*Remote sensing, \*Satellite technology,

\*Snow, Anisotropy, Antarctica, Bidirectional re-flectance, Greenland, New snow, Old snow.

Satellite detectors with narrow field of view measure bidirectional reflectance at only one or a few angles. To obtain the planetary albedo from individual satellite measurements, it is necessary to have prior knowledge of the bidirectional reflectance. There have been only few studies of direc-tional reflectance of snow measured at the ground. The bidirectional reflectance of high altitude powder snow, new snow, and old snow was measured under various zenith angles at 500-600 nano-meter wavelength. Powder snow with grain radii of 0.15 mm has a nearly isotropic uniform reflec-tance pattern. However, at a reflectance angle of 75 deg, forward scattering > 1.2 anisotropic reflectance function (ARF) units was found at all solar zenith angles (SZAs) in the principal plane of solar zentiti angles (32.35) in the principal piane of the sun. The anisotopic reflectance is better developed for new snow than for powder snow and most developed for old snow. For old snow, with grain radii varying from 1-3 mm, maximum ARF grain radii varying from 1-3 mm, maximum ARF values > 2.0 were found for a reflectance angle of 75 deg for all SZAs. Comparative data obtained with the Nimbus-7 satellite for Antarctic and Greenland icecaps showed an ARF value of 1.5 for a reflectance angle of 75 deg and an incidence angle of 60-66 deg in the direction of the sun, a value which lies between the ARF values of powder snow and new snow surfaces found in the ground-based study. (See also W91-10338) (Rochester-PTT) ester-PTT) W91-10373

MICROSPRAYER IRRIGATION FOR COLD PROTECTION. Texas A and M Univ., Weslaco. Agricultural Re-search and Extension Center. For primary bibliographic entry see Field 3F. W91-10460

#### 2D. Evaporation and Transpiration

INFILTRATION AND EVAPOTRANSPIRA-TION WITHIN THE ALBUQUERQUE, NEW MEXICO, AREA WITH A SECTION ON HIS-TORICAL WATER-RESOURCE TRENDS DURING THE 1954-80'S PERIOD OF URBAN GROWTH.

Geological Survey, Albuquerque, NM. Water Resources Div. C. L. Goetz, and S. G. Shelton.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4056, 1990. 80p, 25 fig, 9 tab.

Descriptors: \*Evapotranspiration, \*Infiltration, \*Surface-groundwater relations, \*Urban hydrology, \*Water use, Streamflow, Unsaturated flow, Urban development, Urban runoff.

The mean infiltration at Grant Line Arrovo in northeast Albuquerque, New Mexico was 2,158 cu ft or 0.05 acre-ft/mile of arroyo. For this unlined sand channel the mean infiltration was 13.7% of rainfall. Irrigation increased the evapotranspiration rate two to five times over nonirrigated land. With the growth in the city of Albuquerque's residential land, an increase in evaporate water use can be expected. Annual groundwater withdrawal from the Albuquerque metropolitan area more than tri-pled in 26 years from 31,000 acre-ft in 1954 to 105,000 acre-ft in 1980. Water levels declined 0.53 105,000 acre-ft in 1980. Water levels declined 0.53 ft to 1.28 ft/yr in wells within the city of Albuquerque over the period of record tested. Water levels rose 0.04 to 0.19 ft/yr in shallow wells near the Rio Grande between Albuquerque and Bernardo. From 1955 to 1984 streamflow losses on the Rio Grande between San Felipe and Bernardo decreased by 3,528 acre-ft/yr. The Albuquerque metropolitan area, located between these stations, may have contributed to the trend of reduced have contributed to the trend of reduced losses through increased runoff to the Rio Grande caused by land-surface paving and concrete lining of arroyos and increased wastewater flow to the Rio Grande from the city's wastewater treatment plant. (USGS) W91-09551

#### DAILY SURFACE MOISTURE MODEL FOR LARGE SEMI-ARID LAND APPLICATION WITH LIMITED CLIMATE DATA.

National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.

M. Owe, and A. A. Van De Griend.

Journal of Hydrology JHYDA7, Vol. 121, p 119132, December 1990. 10 fig, 12 ref.

Descriptors: \*Evapotranspiration, \*Model studies, \*Semiarid climates, \*Soil water, Climatic data, Drying, Moisture deficiency, Temperature, Vege-

Evapotranspiration and surface soil moisture are Evaporanspiration and surface soil moisture air seldom monitored on a routine basis like other climatic parameters, and consequently must be modeled from whatever data may be available. A simple daily surface moisture model is presented, based on the potential evapotranspiration concept, but modified to yield actual evapotranspiration. Net radiation is the primary driver, but could also be replaced by solar radiation. Data are presented demonstrating the different behavior patterns of soil moisture depletion, depending on whether the surface is vegetation-covered or bare. An extensive data-set collected during a field experiment in Phoenix, AZ in 1971 was analyzed and compared with some data and additional relationships in the literature. A modified Priestley-Taylor concept is used, whereby the alpha term is dynamic, and dependent on the available surface moisture. The relationship between alpha and the surface mois-ture is a result of the drying character of the soil, and very much a function of whether the surface is bare or vegetation-covered. Also, the soil heat flux is shown to be an important parameter which should not be neglected, and may also be estimated from the surface moisture. (Agostine-PTT)

# MODELLING CATCHMENT EVAPORATION: AN OBJECTIVE COMPARISON OF THE PENMAN AND MORTON APPROACHES.

University Coll., Galway (Ireland). P. Doyle.

Journal of Hydrology JHYDA7, Vol. 121, p 257-276, December 1990. 3 fig, 9 tab, 15 ref.

Descriptors: \*Evaporation, \*Hydrologic models, \*Model studies, \*Soil water, \*Watersheds, Advection, Comparison studies, Evaporation rate, Hydrologic budget.

Water-balance data from the Shannon catchment are used to calibrate two simple models of catchment-scale evaporation. The first uses the more traditional approach: evaporation is taken as Penman potential evaporation (PE), unless water is not freely available, in which case the reduction of actual evaporation (AE) from PE is calculated using a simple Thornthwaite-style soil-moisture model. The second model makes use of the relamodel. The second model makes use of the relatively recent work by Bouchet and Morton which suggests, inter alia, that AE and PE are inversely related in the absence of an abundant supply of moisture. The resulting objective criteria of efficiency for the final models are similar, but other results from the model calibration process indicate some of the relative strengths and weaknesses of the two models. Morton's model represents an improvement over Penman's for the purposes of water balance modeling in that the prediction of ter balance modeling in that the prediction of AE does not depend to such an extent on the soil-moisture model component, probably the weakest component in most water balance models. This improvement rests on some theory which may not improvement rests on some theory which may not hold for many catchments. In the case of the catchment used here, model performance was mar-ginally better for Morton's model. This suggests that a reformulation of Morton's model with im-proved modeling of the processes of advection, could realize the promise of a better model which the theory of Bouchet and Morton undoubtedly holds. In particular, it is shown that the Bouchet-Morton approach provides a valuable alternative to the empiricism of the Thornthwaitie-style reduc-tion of AE from PE, but that this is achieved at a high cost: the introduction of a strong degree of empiricism into the process of advection modeling. (Agostine-PTT)

W91-09722

APPLICATION OF SATELLITE REMOTE SENSING TO ESTIMATE AREAL EVAPOTRANSPIRATION OVER A WATERSHED. National Board of Waters, Helsinki (Finland). Y. Suchsdorff, and C. Ottle. Journal of Hydrology JHYDA7, Vol. 121, p 321-333, December 1990. 5 fig, 3 tab, 15 ref.

Descriptors: \*Aerial photography, \*Evapotran-spiration, \*Finland, \*Remote sensing, \*Satellite technology, \*Watersheds, Hydrologic budget, Mathematical studies, Model studies, Simulation analysis, Soil temperature, Synoptic analysis, Vegetation, Weather data.

A method for estimating areal evapotranspiration by using synoptical weather data and satellite im-agery is presented. Recent studies have shown that if atmospheric and surface parameters are known, the energy and hydraulic budgets at the soil/vege-tation/atmosphere interface can be simulated. tation/atmosphere interface can be simulated. Then, soil temperature estimated by thermal infrared remote sensing can be used to derive the energy fluxes as far as they are the equilibrium term of the energy budget. This methodology has been applied in southwestern Finland over the Eurajoki River basin. The model was first calibrated with ground measurements and estellite destilities. Eurajoki River basin. The model was first calibrated with ground measurements and satellite data. The normalized difference vegetation indexes and the surface temperature estimated from NOAA/AVHRR data have been used to calibrate the leaf area index and the minimum resistance to evaportanspiration. The different land use classes over the river basin were interpreted from LANDSAT/TM images, and the model was then run over the whole month of July 1988 for all the most important soil and vegetation types of the river basin. tant soil and vegetation types of the river basin. Finally, the total derived evaporation was comrinally, the total derived evaporation was com-pared with the one estimated by a water balance method applied over the month of July. The monthly cumulative evaportranspiration values cal-culated by the model compare very well with the same parameter deduced from the water balance method. Although the results have no statistical meaning, the agreement between the two methods may be considered as an indication of the potential of the methodology. The same validation of the simulated evapotranspiration must now be done over longer time periods, to test the accuracy of the model. (Author's abstract) W91-09725

COMPARISON OF SHORT-TERM MEASURE-MENTS OF LAKE EVAPORATION USING EDDY CORRELATION AND ENERGY BUDGET METHODS. Geological Survey Denner CO

Geological Survey, Denver, CO. D. I. Stannard, and D. O. Rosenberry. Journal of Hydrology JHYDA7, Vol. 122, p 15-22, January 1991. 3 fig, 6 ref.

Descriptors: \*Eddy correlation, \*Energy, \*Energy budget, \*Evaporation, \*Lake evaporation, \*Mathematical studies, \*Water currents, Comparison studies, Correlation analysis, Energy transfer, Heat transfer, Model studies, Radiometry.

Estimates of lake evaporation using the energy budget method were shown to be accurate to within 5% for periods of a week or more at Lake Hefner, OK. Eddy correlation methods to estimate evaporation within 10% for 30-min periods have evaporation within 10% 107 30-min periods have been developed recently to the degree that they can be applied relatively easily. Consequently, eddy correlation measurements were made at Island Lake, NE, a site where energy budget data are being collected on a routine basis, to compare the two methods. Results of concurrent short-term reassurements of evaporation using eddy correlations. measurements of evaporation, using eddy correla-tion and energy budget methods, indicate that sen-sible and latent heat flux between lake and atmosphere, and energy storage in the lake, may vary considerably across the lake. Measuring net radiation with a net radiometer on the lake appeared to be more accurate than measuring incoming radiation nearby and modeling outgoing radiation. Short-term agreement between the two evaporation measurements was obtained by using an energy storage term that was weighted to account

for the area-of-influence of the eddy correlation sensors. Relatively short bursts of evaporation were indicated by the eddy correlation sensors shortly after midnight on two of three occasions. (Agostine-PTT) W91-09732

INFLUENCE OF SOIL, PLANT AND METEOR-OLOGICAL FACTORS ON WATER RELA-TIONS AND YIELD IN HEVEA BRASILIEN-

Rubber Research Inst. of India, Kerala. For primary bibliographic entry see Field 2I. W91-09953

SPATIAL VARIATION IN THE ESTIMATION OF EVAPOTRANSPIRATION POTENTIAL IN SOUTHERN QUEBEC (VARIABILITE SPATIALE DE L'ESTIMATION DE L'EVAPOTRANSPIRATION POTENTIELLE AU QUEBEC MERIDIONAL). Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre. P. Rochette, and P. Dube. Naturaliste Canadien NCANAS, Vol. 116, No. 4, p 267-278, 1989. 5 tab, 12 ref, 2 append. English summary.

Descriptors: \*Evapotranspiration, \*Evapotranspiration potential, \*Mathematical models, \*Model studies, \*Model testing, \*Penman equation, \*Quebec, Calibrations, Canada, Error analysis, Seasonal variation, Spatial variation.

An empirical model for potential evapotranspira-An empirical model for potential evapotranspira-tion (ETP) estimation was calibrated at 12 sites in southern Quebec. Locally calibrated models were compared and their utilization was judged statisti-cally superior to that of a model calibrated on all stations data. Although accurate for the whole growing season, the ETP estimates produced by regional models were found to be systematically higher than those given by Penman's equation at the beginning and at the end of the season, and lower during July and August. An empirical cor-rection coefficient is proposed to minimize this effect. The standard deviation of the estimation effect. The standard deviation of the estimation error by regional models, expressed as a percentage of the ETP estimates by Penman's equation, was 28% for one day, 20% for 3 days, 14% for 7 days, 13% for 10 days, 8% for 30 days and 3% for the entire season. (Author's abstract)

SOME PHYSIOLOGICAL PROCESSES IN THE ECOSYSTEM OF A FLOODPLAIN FOREST. Brno Univ. (Czechoslovakia).

M. Penka.

In: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 295-324, 10 fig, 8 tab, 49 ref.

Descriptors: \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Oak trees, \*Riparian vegetation, \*Transpiration, Diurnal variation, Evapotranspiration, Humidity, Photosynthesis, Plant physiology, Solar radiation

The problems of the productivity of the ecosystem of a floodplain forest are very closely connected with the problems of physiological processes, particularly of the water relations and of photosynthesis. A summary and evaluation was made of results obtained from an investigation of water relations of the pedunculate oak (Quercus robur L.), the dominant tree species in the floodplain studied (in Czechoslovakia), with regard to growth and development, and changes in some hydrometeorological elements. The diurnal course of the rate of the transpiration of an adult Quercus robur L. was transpiration of an adult Quercus robur L. was characterized by both one-peak curves with a midday maximum, and two-peak curves with a midday depression. Different intensity of transpiration in the course of the day was measured in shoots from the apical and basal parts of the crown and in shoots from the eastern and western parts of the crown. It was found that the values of the rate of photosynthesis in an adult Q. robur were highest Streamflow and Runoff-Group 2E

in leaves from the apical, and lowest in leaves from the basal crown zone. If, however, the rate of photosynthesis was expressed as the dry matter increment per unit of fresh matter, the course was increment per unit of treas matter, the course was the reverse. A comparison of the results obtained in investigations of transpiration in this tree showed that the rate of transpiration and transpira-tion flow in the diurnal period were in relatively good agreement. The greatest dependencies were found in solar radiation and air humidity (and/or vapor saturation and air humidity (and/or vapor saturation deficit and evaportanspiration rate), and partly also in air temperature. Significant changes were found in the dependencies in the course of the diurnal period. (See also W91-10298) (White-Reimer-PTT) W91-10305

#### 2E. Streamflow and Runoff

EFFECTS OF SPATIAL ACCUMULATION OF RUNOFF ON WATERSHED RESPONSE, Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 31-35, January/March 1991. 4 fig, 1 tab, 13 ref.

Descriptors: \*Drainage patterns, \*Rainfall-runoff relationships, \*Runoff, \*Spatial distribution, \*Watersheds, Drainage area, Hydrologic models, Model studies, Rainfall distribution, Runoff

A drainage network accumulates upstream subwatershed runoff into a single downstream response, with runoff accumulating at network junctions. The effects of this accumulation on the magnitude and spatial variability of the downstream response can be isolated using simplified boundary condi-tions; the parameters are runoff depth and corre-sponding unit area peak runoff rate. At the subwasponding unit area pear knuon rate. At the subwatershed level these parameters are referred to as d and q, respectively, and they vary from one subwatershed to another. At a downstream location, after accumulation by the drainage network, corresponding parameters are referred to as D and Q. Equations expressing the effects of runoff accumulations expressing the effects of runoff accumulations. lation were formulated for uniform rainfall condi-tions and indicate that the effects of runoff accu-mulation gain in importance as the number of upstream subwatersheds and the size of the watershed increase in the downstream direction. The accumulation process cancels extreme values of d and q to yield representative D and Q values for and q to yield representative D and Q values for individual d and q diminishes as the number of upstream subwatersheds increases. This results in a decrease in the spatial variability of D and Q in the downstream direction. Therefore, the role of spadownstream d and q in the determination of downstream D and Q diminishes as watershed size increases. However, nonuniform rainfall distributions and storm movement may overshadow the effects of runoff accumulation watershed size increases beyond the size of the storm. (Doyle-PTT) W91-09331

OBSERVATIONS ON THE WETLAND ECO-SYSTEM OF KABAR LAKE IN BEGUSARAI, BIHAR, WITH SPECIAL REFERENCE TO VEGETATION.

Botanical Survey of India, Howrah (India). For primary bibliographic entry see Field 2H. W91-09360

IMPACT OF RIVERINE WETLANDS CON-STRUCTION AND OPERATION ON STREAM CHANNEL STABILITY: CONCEPTUAL FRAMEWORK FOR GEOMORPHIC ASSESS-

Illinois Univ., Urbana. Dept. of Geography. For primary bibliographic entry see Field 2H. W91-09366

BACKWATER CURVES IN CIRCULAR CHAN-

#### Field 2—WATER CYCLE

#### Group 2E-Streamflow and Runoff

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt füer Wasserbau, Hydrologie und Glaziologie. W. H. Hager. Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 173-183, March/April 1991. 7 fig, 1 tab, 15 ref, append.

Descriptors: \*Backwater curve, \*Channel flow, \*Flow equations, \*Mathematical equations, \*Open-channel flow, Channel morphology, Channels, Conduits, Drainage engineering, Flow models, Uniform flow.

Backwater curves in circular sewers and drainage onduits are evaluated using a new method based on simple expressions for uniform and critical flows, and a transformation of the longitudinal coordinate by which the effect of relative uniform flow depth may be incorporated. The free surface profile depends on two independent parameters: (1) the dynamics of flow; and (2) the relative uniform flow depth. The relative filling for uniform flow parameter can be transformed and in-cluded in a modified length coordinate, whose result corresponds to the Tolkmitt equation. As a result, the method presented allows for an explicit determination of any backwater effect. In large determination of any backware effect. In large sewer and drainage systems, the computing time and effort may now be reduced. The present solu-tion, when approximated, may satisfy the demands in practice. (Brunone-PTT) W91-09392

NORMAL-DEPTH CALCULATIONS IN COM-PLEX CHANNEL SECTIONS.

PLEA CHANNEL SECTIONS.
Agricultural Research Service, Tucson, AZ.
E. D. Shirley, and V. L. Lopes.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, VOI. 117, No. 2, p 220-232,
March/April 1991. 4 fig, 5 tab, 6 ref, append.

Descriptors: \*Channel flow, \*Channel morphology, \*Computer programs, \*Data interpretation, \*Flow equations, \*Flow models, \*Open-channel flow, Chezy equation, Convergence, Mannings equation, Mathematical equations, Mathematical studies, Precision

The general problem of solving for normal flow depth in open-channel flow has a complication in that some types of channel cross sections do not always have a unique solution. An alternative itarways have a unique souther. An attentive it-erative procedure as developed, using Chezy or Manning equations, to quickly and accurately solve the implicit problem of determining the normal flow depth in complex channel sections. Conditions were ensured that guarantee a unique solution and that the iterative procedure will converge to that solution. A computer program of the procedure, in FORTRAN, is available. Test runs for a rectangular, a triangular, a trapezoidal, and two complex channel cross sections were used to evaluate the effectiveness of the procedure. The test runs show that the algorithm always converged for a convergence tolerance of .000001 or more, and that absolute errors were not affected by initial flow depth guess. The test results also show that this iterative procedure meets the require-ments of guaranteed convergence, computational efficiency (speed and accuracy), and the ability to handle both trapezoidal and complex channel cross sections. (Brunone-PTT) W91-09395

CALCULATION OF A HYDRAULIC JUMP ON THE BASIS OF A HYBRID MODEL. For primary bibliographic entry see Field 8B.

TRANSIENT PROCESSES IN CANALS WITH For primary bibliographic entry see Field 8B. W91-09458

ALLUVIAL RIVER BED TRANSPORT PROC-ESS WITH GRADED MATERIAL.

California Univ., Berkeley. For primary bibliographic entry see Field 2J.

W91-09472

STREAM-AQUIFER SYSTEM IN THE UPPER BEAR RIVER VALLEY, WYOMING. Geological Survey, Cheyenne, WY. Water Resources Div.

For primary bibliographic entry see Field 2A. W91-09489

WATER RESOURCES FOR ALASKA, WATER Geological Survey, Anchorage, AK. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09507

WATER RESOURCES FOR COLORADO, WATER YEAR 1988, VOLUME 2, COLORADO

Geological Survey, Lakewood, CO. Water Re-For primary bibliographic entry see Field 7C. W91-09508 sources Div.

WATER RESOURCES DATA FLORIDA, WATER YEAR 1989, VOLUME 4. NORTHWEST FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09509

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09510

WATER RESOURCES DATA FOR MISSISSIP-PI, WATER YEAR 1989.

Geological Survey, Jackson, MS. Water Resources For primary bibliographic entry see Field 7C.

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1983. Geological Survey, San Juan, PR. Water Re-For primary bibliographic entry see Field 7C. W91-09512 sources Div.

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1984. Geological Survey, San Juan, PR. Water Re-For primary bibliographic entry see Field 7C. W91-09513 sources Div.

WATER RESOURCES DATA SOUTH CAROLI-NA, WATER YEAR 1988. Geological Survey, Columbia, SC. Water Re-

sources Div.
For primary bibliographic entry see Field 7C.
W91-09514

WATER RESOURCES DATA FOR WASHING-TON, WATER YEAR 1985. Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09515

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1989, VOLUME 3. WESTERN NEW YORK

Geological Survey, Ithaca, NY. Water Resources Div For primary bibliographic entry see Field 7C.

WATER RESOURCES DATA FOR WISCON-SIN, WATER YEAR 1985.
Geological Survey, Madison, WI. Water Re-

sources Div. For primary bibliographic entry see Field 7C. W91-09517

CLIMATIC VARIABILITY AND FLOOD FRE-QUENCY OF THE SANTA CRUZ RIVER, PIMA COUNTY ARIZONA.

Geological Survey, Tucson, AZ. Water Resources

R. H. Webb, and J. L. Betancourt. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-553, 1990. 69p, 21 fig, 10 tab, 95 ref. Project No. AZ107.

Descriptors: \*Arizona, \*Climatology, \*El Nino, \*Flood forecasting. \*Flood frequency, \*Flood re-\*Flood forecasting, \*Flood frequency, \*Flood recurrence interval, Pima County, Rainfall-runoff relationships, Santa Cruz River, Tropical cyclones,

Past estimates of the 100-yr flood for Santa Cruz River at Tucson, Arizona, range from 572 to 2,780 cu m/sec. An apparent increase in flood magnitude during the past two decades raises concern that the annual flood series in nonstationary in time. The apparent increase is accompanied by more annual floods occurring in fall and winter and fewer in notus occurring in tail and winter and fewer in summer. This greater mixture of storm types that produce annual flood peaks is caused by higher frequency of meridional flow in the upper-air circulation and increased variance of ocean-atmosphere conditions in the tropical Pacific Ocean. Estimation of flood frequency on the Santa Cruz Estimation of inod frequency on the santa Cruz River is complicated because climate affects the magnitude and frequency of storms that cause floods. Mean discharge does not change significantly, but the variance and skew coefficient of the distribution of annual floods change with time. the 100-year flood during El Nino/Southern Oscillation (ENSO) conditions is 1,300 cu m/sec-more than double the value for other years. The increase is mostly caused by an increase in recurvature of dissipating tropical cyclopes into the southwestern is mostly caused by an increase in recurvature of dissipating tropical cyclones into the southwestern United States during ENSO conditions. Flood frequency based on hydroclimatology was determined by combining populations of floods caused by monsoonal storms, frontal systems and dissipating tropical cyclones. For 1930-59, annual flood frequency is dominated by monsoonal floods, and the estimated 100-year flood is 323 cu m/sec. For 1960-86 annual flood frequency at recurrence in the estimated 100-year flood is 3.23 cu m/sec. For 1960-86, annual flood frequency at recurrence intervals of greater than 10 years is dominant by floods caused by dissipating tropical cyclones, and the estimated 100-yr flood is 1,660 cu m/sec. For design purposes, 1,660 cu m/sec might be an appropriate value for the 100-year flood at Tucson, assuming that climatic conditions during 1960-86 are representative of conditions expected in the immediate future. (USGS) W91-09529

SURFACE-WATER HYDROLOGY OF HONEY LAKE VALLEY, LASSEN COUNTY, CALIFORNIA, AND WASHOE COUNTY, NEVADA. Geological Survey, Carson City, NV. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09531

ANNUAL PEAK DISCHARGES FROM SMALL DRAINAGE AREAS IN MONTANA THROUGH SEPTEMBER 1989.

Geological Survey, Helena, MT. Water Resources

J. A. Hull, and R. J. Omang

J. A. Hull, and R. J. Omang. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-577, 1990. 143p, 1 fig, 5 ref.

Descriptors: \*Montana, \*Peak discharge, \*Peak flow, \*Streamflow data, Maximum stage.

Peak-streamflow data have been collected in Montana since July 1955, and are presented in this report. Originally, 45 crest-stage gaging stations

were established. Since 1955, the program of data collection has been expanded and reevaluated. As of the end of water year 1989, data were being collected at 158 stations and had been collected at 328 total stations. The stations record peak stages of flow from upstream drainage areas that range in of now from upstream dramage areas than trange in size from less than I square mile to several hundred square miles. The purpose of the program is to collect sufficient peak-flow data to permit development of methods for estimating the magnitude and frequency of floods at any point in Montana. For each station, this report briefly describes the

station location, drainage area, period of records available and type of gage including altitude of gage. The tabular data consist of annual maximum gage height and discharge listed by water year and month or month and day. (USGS) W91-09539

WATER-RESOURCES ACTIVITIES IN UTAH BY THE U.S. GEOLOGICAL SURVEY, OCTO-BER 1, 1988, TO SEPTEMBER 30, 1989. Geological Survey, Salt Lake City, UT. Water

Resources Div.
For primary bibliographic entry see Field 7C.
W91-09540

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1990, VOLUME 1B: NORTH-EAST FLORIDA - GROUND WATER.

Geological Survey, Altamonte Springs, FL. Water Resources Div For primary bibliographic entry see Field 7C. W91-09545

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources

For primary bibliographic entry see Field 7C. W91-09546

WATER RESOURCES DATA FOR TENNES-SEE, WATER YEAR 1989.
Geological Survey, Nashville, TN. Water Re-

sources Div.

For primary bibliographic entry see Field 7C. W91-09547

GROUND-WATER-FLOW SYSTEMS IN THE POWDER RIVER STRUCTURAL BASIN, WYO-MING AND MONTANA.

Geological Survey, Cheyenne, WY. Water Re-

J. G. Rankl, and M. E. Lowry J. G. Kanki, and M. E. LOWRY. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4229, 1990. 39p., 23 fig, 3 tab, 1 pl, 28 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Streamflow, \*Surface-groundwater relations, Alluvial aquiffers, Base flow, Flow dura-tion, Hydrographs, Montana, Wyoming.

This study was one of several done under the U.S. Geological Survey coal-hydrology program to describe the water resources of areas of coal development and to determine the effects of the development. ment on the water resources. The three largest streams included in the analysis were the Powder, Belle Fourche, and Cheyenne Rivers. Only the Belle Fourche had base flow, and it was present only during the period of greatest precipitation. The absence of base flow derived from groundwater moving through the regional system is the result of the nonhomogeneity of the formations. Analysis of streamflow records indicates that alluvial and clinker aquifers have more measurable effect on flow at the stations analyzed than bedrock aquifers. The alluvium contributes flow to some streams, but it is believed that the prevalent condition is that the streams lose water to the alluvium to replace water discharged by evapotranspiration. It was concluded that measurable effects would be on local rather than regional groundwater flow systems in the Powder River structural basin. Re-

gional flow of shallow groundwater into streams and regional flow northward can be inferred from potentiometric data, but such flow could not be identified. (USGS)

USE OF PALEOFLOOD INVESTIGATIONS TO IMPROVE FLOOD-FREQUENCY ANALYSES OF PLAINS STREAMS IN WYOMING.

Geological Survey, Cheyenne, WY. Water Resources Div. M. E. Cooley.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4209, 1990. 75p, 37 fig, 6 tab, 16 ref. Project No. WY010.

Descriptors: \*Flood forecasting, \*Flood frequency, \*Historic floods, \*Paleofloods, \*Paleohydrology, \*Wyoming, Flood peak, Flood recurrence interval, Plains streams.

Paleoflood techniques were used to obtain additional information on historical streams and to improve flood-frequency curves of short-term (8 to 23 water years) peak-flow records of ephemeral plains streams in Wyoming. Onsite reconnaissance recorded conspicuous drainage features and historical flows. These features included: (1) Geomorphic features, including fluvial terraces and bottom land channels; (2) flood deposits; (3) vegetation (as affected by floods); and (4) soils. Study-area drain-ages are classified geomorphically, and peak flows are classified as to their relative magnitudes based are classified as to their relative magnitudes based on their relation to geomorphic features (principally terraces) and to other features; this classification allows comparison of flows of different drainages. Peak flows were related to geomorphic features, and short-term records were extended for the 21 study drainages. Most records were extended to a maximum of 200 years. The estimated 50-year flood was increased for 7 drainages and decreased for 14 drainages. (USGS) W91-09549

STREAMFLOW LOSSES AND GROUND-WATER LEVEL CHANGES ALONG THE BIG LOST RIVER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO. Geological Survey, Idaho Falls, ID. Water Resources Div.

sources Div.

For primary bibliographic entry see Field 2F. W91-09552

TREND ANALYSIS OF SELECTED WATER-QUALITY CONSTITUENTS IN THE VERDE RIVER BASIN, CENTRAL ARIZONA. Geological Survey, Tucson, AZ. Water Resources

For primary bibliographic entry see Field 5B. W91-09555

GEOGRAPHIC INFORMATION SYSTEM DATA BASE FOR COAL AND WATER RE-SOURCES OF THE POWDER RIVER COAL REGION, SOUTHEASTERN MONTANA.
Geological Survey, Helena, MT. Water Resources

For primary bibliographic entry see Field 7C. W91-09557

WATER-RESOURCES INVESTIGATIONS IN TENNESSEE: PROGRAMS AND ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY, 1990-91. Geological Survey, Nashville, TN. Water Re-

For primary bibliographic entry see Field 7C. W91-09558

CHEMICAL INTERACTIONS BETWEEN SURFACE WATER AND GROUND WATER IN THE ZEKIAH SWAMP RUN STREAM VALLEY. Environmental Resources Management, Inc., An-

napolis, MD. For primary bibliographic entry see Field 2F. W91-09631

#### Streamflow and Runoff-Group 2E

IMPACTS OF HIGHWAY DEICING PROGRAMS ON GROUNDWATER AND SURFACE WATER QUALITY IN MARYLAND.

GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5B. W91-09648

PATTERN OF GYPSUM TRANSPORT IN THE EBRO RIVER NETWORK.

Exeter Univ. (England). Dept. of Geography.

A. Navas.
Catena, Vol. 18, No. 1, p 45-49, February 1991. 2 fig, 10 ref.

Descriptors: \*Gypsum, \*River basins, \*Saline water, \*Solute transport, \*Spain, \*Watershed management, Nonpoint pollution sources, Pollution load, River sediments, Salinity, Water pollution

The Ebro river basin (northeast Spain) is underlain in its central sector by thick, evaporitic facies deposited during the Tertiary era. Dissolution of these rocks is the main source of high ionic concentrations in the Ebro river network. Previous studies dealing with salinization problems in the Ebro basin have concluded that water resources planning requires a fundamental understanding of the origin and impact of salinity, and of the most effective method of reduction of the natural load of salts. This can best be achieved by reducing the gypsum contribution to salinity, and therefore it is important to quantify the contribution. gypsum contribution to salinity, and therefore it is important to quantify the contribution of gypsum to the total salinity in the different reaches of the Ebro river network. A study of gypsum transport in the Ebro river basin during the hydrological period 1970-85 was carried out. Gypsum load increases throughout the network and reaches 2.95 million tons per year (43% of total salinity) at Tortosa, the mouth of the basin. As a whole, the Ebro basin annually supplies 35 tons of gypsum per square km of surface area to the sea. Non-point sources are the major contributors to gypsum supplies. The tributaries on the Ebro's left bank supply the highest load, but those on the right bank exhibit the highest concentrations of gypsum. (Fish-PTT) PTT) W91-09691

FIELD STUDY ON TOPOGRAPHICAL AND TOPSOIL EFFECTS ON RUNOFF GENERATION.

Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.

G. Govers.
Catena, Vol. 18, No. 1, p 91-111, February 1991. 9 fig. 3 tab, 26 ref.

Descriptors: \*Rainfall-runoff relationships, \*Sediment transport, \*Slope effects, \*Surface runoff, \*Topsoil, Belgium, Loam, Runoff plot, Runoff volume, Soil types, Topography.

The influence of structural, textural, and topographical effects on runoff generation has been reported earlier in literature; however, literature is ambiguous about the effect of slope on runoff generation. Runoff production was studied on small plots under natural meteorological conditions small plots under natural meteorological conditions to evaluate the effects of slope, length, and topsoil characteristics and assess runoff yield in central Belgium. The data show that slope has in many cases a significant negative effect on runoff yield: this result can partly be explained by the conceptual model of Poesen. However, differential soil cracking also plays a major role, even on the loamy soils under study. On the plateau site runoff wield is generally resiriely resired to plot length. yield is generally positively related to plot length, which is due to the differentiation of crust characwhich is due to the differentiation of relational characteristics with distance downslope. This phenomenon does not occur on steep slopes, so that runoff yield is here lower on longer plots. This implies that the slope effect may even be more important on larger surfaces. (Author's abstract) W91-09693

STUDY OF RIVER CHANNEL PATTERN IN-FORMATION RECORDED BY GRAIN SIZE PARAMETERS OF FLUVIAL SEDIMENT.

#### Field 2—WATER CYCLE

#### Group 2E-Streamflow and Runoff

Academia Sinica, Beijing (China). Inst. of Geography. For primary bibliographic entry see Field 2J. W91-09699

DISCUSSION ON UNBIASED PLOTTING PO-SITIONS FOR THE GENERAL EXTREME VALUE DISTRIBUTION.

University Coll., Galway (Ireland). Dept. of Engi-For primary bibliographic entry see Field 7C. W91-09710

UNBIASED PLOTTING POSITION FORMU-LAE FOR HISTORICAL FLOODS, University Coll., Galway (Ireland). Dept. of Engi-

neering Hydrology.
For primary bibliographic entry see Field 7C.
W91-09711

ACID NEUTRALIZATION CAPACITY VARIATIONS FOR THE HAFREN FOREST STREAM, MID-WALES: INFERENCES FOR

SIREAM, MIDWALES: INFERENCES FOR HYDROLOGICAL PROCESSES.
Institute of Hydrology, Wallingford (England).
C. Neal, A. Robson, and C. J. Smith.
Journal of Hydrology JHYDA7, Vol. 121, p 85101, December 1990. 11 fig, 1 tab, 30 ref.

Descriptors: "Acid rain, "Acid streams, "Acidic water, "Environmental tracers, "Forest watersheds, "Geochemistry, "Wales, "Water chemistry, "Watershed management, Acid neutralizing capacity, Flow, Hydrogen ion concentration, Hydrographs, Hydrologic data, Mathematical analysis, Slopes, Storm runoff, Variability.

Water tracing using hydrochemical techniques has provided an important tool for separating the hy-drograph between that component displaced from the catchment (old water) and that supplied directly from the rainfall generating the stormflow response (new water). A chemical technique for exploring the relative contributions of different water sources to streamflow during storm events is presented. This chemical technique uses mixing presented. This chemical technique uses mixing relationships for a conservative component, the Acid Neutralization Capacity (ANC), and has been applied to stream data for the Hafren forest catchment, mid-Wales. For short-term events, a method of estimating ANC from pH data collected in the field, by continuous stream water measurements, is derived using calibrations from weekly data. A distinction is made between hillslope (soil) and deeper (non-hillslope) sources in the valley bottom (here termed 'endmembers'). The results suggest that rainfall displaces water from bott sources (endmembers) during stormflow; the deeper source (endmembers) during stormflow: the deeper source waters form a volumetrically important component waters form a vountertically important component at all levels of flow, the maximum proportion occurs at baseflow. A simple sensitivity analysis is provided to assess the effects of changing end-member compositions. (Author's abstract) W91-09713

EFFECTS OF WILDFIRE ON SOIL WETTA-BILITY AND HYDROLOGICAL BEHAVIOUR OF AN AFFORESTED CATCHMENT.

Natal Univ., Pietermaritzburg (South Africa). D. F. Scott, and D. B. Van Wyk. Journal of Hydrology JHYDA7, Vol. 121, p 239-256, December 1990. 5 fig, 4 tab, 46 ref.

Descriptors: "Forest fires, "Forest watersheds, "Hydrologic properties, "Overland flow, "Rainfall-runoff relationships, "Soil properties, "South Africa, "Wettability, Sediments, Storm runoff, Streamflow data, Water repellent soils.

A wildfire in February 1986 destroyed most of an afforested research catchment in the southwestern Cape region of South Africa. The hydrological consequences of the fire were quantified using monitored pre-fire and post-fire stream flow and sediment data from the burned catchment and a nearby control catchment. Soil loss and soil wetta-bility were also measured. In the first year after the fire, weekly stream flow totals increased by 12%, quick flow volumes increased by 201%, peak flow

rates increased by 290% and catchment response ratio increased by 242%. Soil loss on overland flow plots ranged from 10 to 26 t/ha, and suspended sediment and bedload yields each increased roughly four-fold following the fire. Wettability of the soils was greatly reduced by the passage of fire. Surface soil layers (0-10 mm) were burned clean of any inherent water renellency by the passage of a Surface soil layers (0-10 mm) were burned clean of any inherent water repellency by the passage of a hot fire, but more severe repellency, in broader bands, was induced in deeper soil levels by the heating of the soil. It is postulated that the wide-spread development of water repellency in the soil led to exceeded flow during legar, rainstorms. led to overland flow during larger rainstorms, which in turn caused the markedly altered hydro-logical behavior of the catchment and the high soil sses relative to the unburned condition. (Author's W91-09721

MATCHED DIFFUSIVITY TECHNIQUE AP-PLIED TO KINEMATIC CASCADES: I. MODEL DESCRIPTION AND VALIDATION. Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.

Journal of Hydrology JHYDA7, Vol. 121, p 345-361, December 1990. 5 fig, 2 tab, 18 ref, append.

Descriptors: \*Diffusivity, \*Flood routing, \*Model studies, \*Model testing, \*Overland flow, \*Routing, \*Runoff forecasting, \*Watersheds, Kinematic cascades. Simulation analysis.

Three models of overland flow based on the matched diffusivity approach were applied to sets of experimental data. These models were: (a) the of experimental data. These models were: (a) the Muskingum-Cunge (MC) technique, with variable parameters; (b) the Muskingum-Koussis (MK) model, which is formally akin to the so-called 'improved' Muskingum method; and (c) a hybrid of (a) and (b) combining coefficients found by (b) with a weighting parameter derived in accordance with (a). In all cases, an implicit iterative algorithm of solution was used; this was justified by the comparatively high maximum numbers of iter-ations required in some of the simulation runs. Variable-parameter MC routing was the most suit-able method of the three; simulated results were shown to agree reasonably well with recorded values. However, as the experimental data cover only a small number of cases, it is necessary to study the performance of the MC model in more detail. (See also W91-09728) (Agostine-PTT)

MATCHED DIFFUSIVITY TECHNIQUE AP-PLIED TO KINEMATIC CASCADES: II. ANAL-YSIS OF MODEL PERFORMANCE.

Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft. For primary bibliographic entry see Field 7C. W91-09728

RELATION BETWEEN INFILTRATION AND STONE COVER ON A SEMIARID HILLS-LOPE, SOUTHERN ARIZONA. State Univ. of New York at Buffalo. Dept. of

State Univ. of Cooperaphy.

A. D. Abrahams, and A. J. Parsons.

Journal of Hydrology JHYDA7, Vol. 122, p 49-59, January 1991. 3 fig, 1 tab, 29 ref. NATO Grant January 1991. RG. 85/0066.

Descriptors: \*Arizona, \*Hydrologic models, \*Infiltration rate, \*Model studies, \*Rainfall-runoff relationships, \*Slopes, \*Vegetation effects, Burrows, Canopy, Gravel, Kinetic energy, Organic matter, Prediction, Semiarid climates, Simulated rainfall, Soil surfaces, Spatial distribution.

A knowledge of the spatial distribution of infiltra-tion rates is essential to the application of realistic, distributed rainfall-runoff models in semiarid areas. Previous studies of the relationship between infilrrevious studies of the feationiship deveen limitation and stone cover on shrub-covered semiarid hillslopes have yielded both positive and negative correlations. It is suggested that positive correlations result where infiltration measurements are confined to areas between large shrubs. Negative correlations, on the other hand, reflect pronounced

shrub-intershrub differences in infiltration and stone cover and are found where both shrub and intershrub areas are sampled. In a study of a semi-arid hillslope in southern Arizona both shrub and intershrub areas were sampled, and a negative cor-relation was obtained between infiltration and stone cover. This correlation arises from the fact that under shrubs fine sediments have accumulated primarily as a result of differential splash, whereas between shrubs such sediments have been edec between shrubs such sediments have been selec-tively removed by a combination of rainsplash and overland flow, leaving behind a gravel lag. Consequently, infiltration rates are higher under shrubs than between them, owing to the higher percentage of sand in the surface soil, the larger quantity of organic matter both within the soil and on its surface and the greater digging and burrowing by animals. In addition, simulated rainfall experiments imply that shrubs with moderately dense canopies are more effective than adjacent surface gravels in are more effective than adjacent surface graves in dissipating the kinetic energy of raindrops and thus reducing surface sealing and promoting infiltration. The inverse relationship observed between infiltration rate and stone cover are probably characteris-tic of such hillslopes and may be used to predict the spatial distribution of infiltration rates for inclusion in rainfall-runoff models. (Author's abstract) W91-09735

APPROACH TO THE RATIONALIZATION OF STREAMFLOW DATA COLLECTION NET-

Manitoba Univ., Winnipeg. Dept. of Civil Engi-For primary bibliographic entry see Field 7A. W91-09737

SURFACE RUNOFF AND SOIL WATER PER-COLATION AS AFFECTED BY SNOW AND SOIL FROST.

Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences. For primary bibliographic entry see Field 2C. W91-09741

COMPARATIVE ANALYSIS OF SEVERAL CONCEPTUAL RAINFALL-RUNOFF

MODELS. Bologna Univ. (Italy). Ist. di Costruzioni Idrau-

M. Franchini, and M. Pacciani

M. Francinii, and M. Pacciani.
Journal of Hydrology JHYDA7, Vol. 122, p 161219, January 1991. 48 fig, 15 tab, 28 ref. CNR
'Gruppo Nazionale per la Difesa dalle Catastrofi
Idrogeologiche', Operative Unity 1.14 Contract
87.00926.84.

Descriptors: \*Hydrologic budget, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, Comparison studies, Drainage, Hydrography, Mathematical studies, Watersheds.

A study was conducted to compare some of the most well-known conceptual rainfall-runoff models. The aim was (1) to verify the ability of the various models to reproduce the measured flow rates, and (2) to supply a frame of reference for the structure and the connection between the conceptual blocks characteristic of each model, their influence in the overall representation of the effects on the closure section and the ease of calibration and estimation of the parameters, as well as their physical interpretation. The analysis was carried out using data for the Sieve watershed (an affluent of the Arno River), for which precipitation, temof the Arno River), for which precipitation, tem-perature, and hourly flow rate values were avail-able for a four-month period. Analysis of the struc-ture of the various models has shown that interac-tion may exist between the ground-level water balance component and the transfer component; if the water balance component does not describe the the water datalect component does not describe the slow release phenomenon (drainage), this causes an alteration of the transfer component in the memory of the unit hydrograph(s), which generally leads to overestimation of the concentration time (this aspect has been particularly noted in the APIC, XINANJIANG and SSARR models). On the other hand, when an appropriate description of the ground-level water balance is ensured, the type of

#### Streamflow and Runoff-Group 2E

unit hydrographs used in relation to the transfer component may be either parabolic or an inverse gaussian distribution, or any other type. This applies as long as the memory is congruent with the concentration time of the watershed, as the respective differences in form have (under these conditions) little effect on the final result. With the sole exception of the APIC model, all of the models produce similar and equally valid results, in spite of the wide range of structural complexity presented. (Agostine-PTT) W91-09742

ADAPTIVE PREDICTION OF HYDROLOGIC SERIES BY WALSH-KALMAN MODEL, Technical Univ. of Istanbul (Turkey). Dept. of

Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-09743

ADAPTIVE PREDICTION OF HYDROLOGIC SERIES BY WALSH-KALMAN MODEL.
Technical Univ. of Istanbul (Turkey). Dept. of

Civil Engineering.

Z. Sen.
Journal of Hydrology JHYDA7, Vol. 122, p 221-234, January 1991. 5 fig, 1 tab, 20 ref.

Descriptors: \*Hydrologic budget, \*Hydrologic models, \*Hydrology, \*Statistics, \*Time series anal-ysis, Climates, Precipitation, Prediction, Probable maximum precipitation, Saudi Arabia, Streamflow data, Turkey, United States.

The orthogonal Walsh series are proposed as an effective model to account for periodicities in observed hydrologic series. A general formulation of the adaptive Walsh procedure has been developed on the basis of the Kalman filtering technique. This leads to a real-time prediction procedure of the state variables which are monthly hydrologic vari-ables. General formulations of adaptive parameter and state estimates are presented and subsequently and state estimates are presented and subsequently their application is performed for monthly flow and rainfall volume sequences. The Walsh series are attractive because of their piecewise linearity over controllable finite periods, their orthogonality and symmetry, in addition to their simplicity in the basic calculations, which are additions and subtractives. The extractive here were the series of the s tions. The method has been applied to monthly stream flow data from Turkey and the U.S.A., and stream flow data from Turkey and the U.S.A., and monthly rainfall data from Saudi Arabia as a representative of extremely arid zones. Comparison with the already available results indicates that the Walsh functions lead to better adaptive predictions than the Fourier series when combined with the Kalman procedure. (Author's abstract) W91-09743

INFLUENCE OF MACROPORES ON RUNOFF GENERATION FROM A HILLSLOPE SOIL WITH A CONTRASTING TEXTURAL CLASS. Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of

Solis.
K. R. J. Smettem, D. J. Chittleborough, B. G.
Richards, and F. W. Leaney.
Journal of Hydrology JHYDA7, Vol. 122, p 235252, January 1991. 7 fig, 6 tab, 36 ref, append.
Australian Water Research Advisory Council

Descriptors: \*Infiltration, \*Pores, \*Rainfall-runoff Descriptors: "Initiation," rores, "Namar-tunon relationships, "Runoff cycle, "Slopes, "Soil water, Drainage, Flow pattern, Hydraulic properties, Macropores, Mathematical studies, Model studies, Perched water table, Prediction, Recharge, Seasonal variation, Soil profiles, Soil types.

The hydrological response of a well-structured hillslope soil under pasture is described. In this soil, during the winter recharge period, macropores provide pathways for water movement which effectively by-pass the soil matrix. In consequence, a perched water table does not develop within the soil profile. New input water is able to penetrate rapidly through the macropore system within the clayey B horizon to the soil/bedrock interface. A highly transient 'water table' is then established within the macropore system and overland flow

commences only when the capacity of this system is exceeded. During the summer, this flow pattern changes. Although the soil might be expected to absorb water more readily than during winter, overland flow is the dominant runoff mechanism. The macropore-matrix dichotomy of the soil hydraulic properties is characterized in situ using auger hole and disc permeaters. The measured soil auger hole and disc permeaters. The measured soil hydraulic properties are used in a finite element model to predict independently the subsurface runoff response during the winter recharge period and to check the adequacy of a throughflow collection system. The model predictions are in reasonable agreement with measured water tables during drainage. (Author's abstract) W91-09744

HYDROGRAPH SEPARATION: A COMPARISON OF GEOCHEMICAL AND ISOTOPE TRACERS.

Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program. C. Wels, R. J. Cornett, and B. D. Lazerte. Journal of Hydrology JHYDA7, Vol. 122, p 253-274, January 1991. 10 fig, 2 tab, 34 ref.

Descriptors: \*Geochemistry, \*Hydrograph analy-Descriptors: "Occidentary, "Tydrograph analysis, "Hydrographs, "Isotopic tracers, "Runoff, "Storm seepage, "Surface flow, "Tracers, Comparison studies, Infiltration, Kinetics, Magnesium, Podzols, Seasonal variation, Silica, Soil properties, Soil types, Streamflow, Subsurface water,

A chemical hydrograph separation can be used to study runoff processes on a watershed scale pro-vided the soil kinetics of the geothermal tracer are well documented. To separate streamflow into sur-face (SF) and subsurface flow (SSF), the supply of the tracer from the soil should be uniform thro out the soil profile and independent of the residence time of the soil/groundwater. The use of two weathering products, dissolved silica and magnesium, is examined for separating spring runoff into SF and SSF in small headwater streams on the Canadian Shield. Field observations and leaching Canadian Sneid. Field observations and leaching experiments in the laboratory suggested that both tracers were released very rapidly from the podzolic soils. Silica allowed a well-defined separation of streamflow into SF and SSF since it is absent in streamnow into 5r and 55r since it is absent in melt/rain water and its concentration varies little throughout the soil profile. Magnesium was used in those streams with wetlands when silica was not behaving conservatively. Both geochemical tracers behaving conservatively. Both geochemical tracers suggested higher contributions of SSF to total spring runoff (>90%) than estimates (approx. 72%) based on the stable isotope deuterium. This difference may result from laterally flowing soil-water that did not mix with the phreatic-ground-water reservoir. (Author's abstract) W91-09745

FINITE-ELEMENT METHOD FOR THE SO-LUTION OF THE SAINT VENANT EQUA-TIONS IN AN OPEN CHANNEL NETWORK. Gdansk Technical Univ. (Poland). Inst. of Hyrdo-

For primary bibliographic entry see Field 7C. W91-09746

TRAVEL TIME OF RUNOFF CRESTS IN

ISNAEL. Ministry of Agriculture, Jerusalem (Israel). Hydrological Service. A. Ben-Zvi, S. Massoth, and A. P. Schick. Journal of Hydrology JHYDA7, Vol. 122, p 309-320, January 1991. 4 fig, 3 tab, 14 ref.

Descriptors: \*Flood waves, \*Hydrograph analysis, \*Israel, \*Model studies, \*Rivers, \*Runoff, \*Runoff forecasting, \*Traveltime, Flow rates, Hydrometric stations, Hydrometry, Mathematical studies, Regression analysis, Watersheds.

Travel times of crests of runoff events in rivers are determined from records of standard hydrometric stations which are located in series. For all the studied reaches, travel time decreases as discharge increases. Their relationship is formulated by use of a linear regression on logarithmic transformed

data. The parameters of this relationship are regressed on the length and the slope of the reach and on the circularity of the watershed of the upstream station. It is concluded that the formulation of the model is suitable for the description of creat travel along river reaches. tion of the model is suitable for the description of crest travel along river reaches, but a particular calibration is required where high accuracy of the parameter values is sought. It is believed that good accuracy may be obtained through records of experimental watersheds or special-purpose networks, whereas records of a standard hydrometric network are useful for formulation of the model and the design of the special-purpose network. The results of the individual reaches are found to be valid for application for either the upstream or the downstream station, but a regional formula can be derived only for the upstream stations. (Agostine-W91-09749

CHANGES IN BIOTIC INTEGRITY OF A RIVER IN NORTH-CENTRAL TENNESSEE.

nessee Technological Univ., Cookeville. Dept. of Biology. For primary bibliographic entry see Field 4C. W91-09768

CRITICAL STREAM VELOCITIES FOR YOUNG-OF-THE-YEAR SMALLMOUTH BASS IN RELATION TO HABITAT USE.

Wisconsin Univ.-Superior. Center for Lake Superi-For primary bibliographic entry see Field 8I. W91-09769

MULTIPLE MODES OF ADJUSTMENT IN UNSTABLE RIVER CHANNEL CROSS-SEC-

East Carolina Univ., Greenville, NC. Dept. of Geography and Planning. For primary bibliographic entry see Field 2J. W91-09779

ESTIMATION OF VARIABLES AT UNGAGED LOCATIONS BY EMPIRICAL ORTHOGONAL FUNCTIONS.

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.

A. R. Rao, and C. H. Hsieh. Journal of Hydrology JHYDA7, Vol. 123, No. 1/ 2, p 51-67, February 1991. 5 fig, 8 tab, 15 ref.

Descriptors: \*Estimating, \*Gaging, \*Rainfall-runoff relationships, \*Simulation, \*Stream gaging, \*Time series analysis, Gaging stations, Hydrologic data, Mathematical analysis, Probable maximum precipitation.

Variables whose values are estimated at ungaged locations are often used in the design of hydraulic structures. It has been found that the empirical orthogonal function (EOF) method is useful for obtaining precipitation estimates for ungaged locations; however, the accuracy of this method for estimating time series of variables has not been estimating time series of variables has not been tested. A technique based on EOFs was used to estimate hydrologic time series variables at ungaged locations. The technique was applied to estimate daily and monthly rainfall, temperature, and runoff values. The accuracy of the method was tested by application to locations where data are available. The second-order characteristics of the estimated data were compared with those of the observed data. It was found that, if the significant EOF explain most of the total variance, then estimates of hydrological data at ungaged locations cant EOF explain most of the total variance, then estimates of hydrological data at ungaged locations will be good. In order to obtain good estimates at ungaged locations, proper selection of gaging stations where observed data are available is important. Best results are obtained if ungaged locations are surrounded by the gaging stations. The estimates of hydrologic data at ungaged locations crucially depend on the estimated mean and standard deviation because of the standardization ard deviation because of the standardization method used. The second-order characteristics of estimated data were close to those of the observed data. The results indicate that the method is quick and accurate. (Fish-PTT)

#### Group 2E-Streamflow and Runoff

W91-09780

LEAKAGE OF CLOGGED CHANNELS THAT PARTIALLY PENETRATE SURFICIAL

AQUIFERS.
Miami Univ., Coral Gables, FL. Dept. of Civil and Architectural Engineering. D. A. Chin.

D. A. Chin.

Journal of Hydraulic Engineering (ASCE)

JHEND8, Vol. 117, No. 4, p 467-488, April 1991. 15 fig. 1 tab. 21 ref.

Descriptors: \*Clogging, \*Groundwater movement, Leakage, \*Shallow aquifers, \*Surface-groundwater relations, Aquifer characteristics, Aquifer systems, Drawdown, Hydraulic engineering, Open channels, Pumping tests, Transmissivity.

The relationship between leakage from open channels and the channel and aquifer properties have been studied by several researchers in the past; however, major limitations of previous studies in-clude assumptions of symmetrical drawdown from the channel and the neglect to include the role of clogging on these leakage scenarios. A theoretical clogging on these leakage scenarios. A heoretical formulation describing leakage from clogged chan-nels that partially penetrate surficial aquifers has been developed. Leakage characteristics are para-meterized by a reach transmissivity, which is de-fined as the volume flow rate out of the channel per unit length of the channel per unit drawdown. An expression was developed to relate the reach transmissivity to the transmissivity of the forma-tion, mean channel width, distance of drawdown measurement from the channel centerline, ratio of drawdowns on both sides of the channel, and local reach transmissivity associated with clogging. This theoretical expression, and associated limitations, were verified using a fine-scale numerical model. The proposed formulation was field-tested at two channels. The measurements of reach transmissi-vity were found to vary linearly with the draw-down ratio, as predicted by the theory. Further-more, the aquifer transmissivity obtained by fitting the theoretical formulation to the measurements was in close agreement with independently estimated values. (Author's abstract) W91-09812

FLOOD-FREQUENCY DERIVATION FROM KINEMATIC WAVE,

Northwest Hydraulic Consultants, Inc., Kent,

WA. L. Cadavid, J. T. B. Obeysekera, and H. W. Shen Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 489-510, April 1991. 12 fig, 2 tab, 23 ref. United States Army Research Office contract number DAAG29-83-K-0160 with Colorado State University.

Descriptors: \*Flood forecasting, \*Flood frequency, \*Frequency distribution, \*Kinematic wave theory, \*Rainfall-runoff relationships, Flood peak, Frequency analysis, Infiltration, Overland flow, Regression analysis.

The use of derived distributions to predict flood The use of derived distributions to predict flood frequency is relatively new and requires refinement and improvement. An effort has been made to obtain and test a derived flood-frequency distribution applicable to small watersheds in which overland flow is considered an important runoff component. Watersheds were conceptualized as first-order streams with two symmetrical planes. The kinematic wave theory was used to obtain expressions. kinematic wave theory was used to obtain expressions to compute peak discharge and time to peak, as functions of effective precipitation variables and watershed parameters, for four different runoff cases formulated according to whether or not there is concentration on the overland flow plane and in the stream Some of these expressions were and in the stream. Some of these expressions were subsequently improved using regression analysis and kinematic wave simulated results. The prob-abilistic model for rainfall characteristics and the infiltration model were taken from results presented previously in the literature for other derived flood-frequency distributions. The usefulness of the derived distribution approach was tested and suc-cessfully demonstrated through application to two real watersheds. (Author's abstract) W91-09813

WATER-QUALITY CHARACTERISTICS OF INFLOW TO AND OUTFLOW FROM B. EVER-ETT JORDAN LAKE, NORTH CAROLINA,

Geological Survey, Raleigh, NC. Water Resources Div.

R. G. Garrett.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4096, 1990. 49p, 12 fig, 8 tab, 14 ref.

Descriptors: \*B Everett Jordan Lake, \*North Carolina, \*Water quality, Nitrates, Water pollution sources.

B. Everett Jordan Lake, a 13,900-acre reservoir in the north-central Piedmont of North Carolina, was completed in February 1982. Hydrologic data were collected at four inflow sites and one outflow site to define water-quality characteristics. Data include streamflow data and 56 physical and chemical characteristics of streamwater. Concentrations of some constituents at inflow sites were as much as 83-times greater than background concentrations in streams relatively unaffected by man. At the outflow site, however, some of these constitu-ents were only as much as 6-times greater. The minimum dissolved-oxygen concentration measured at an inflow site was 1.0 mg/L, whereas the minimum concentration measured at the outflow site was 4.9 mg/L. Significant differences in other physical characteristics between inflow and outflow sites include a reduction in maximum concentration of suspended sediment from 2,360 mg/L in an inflow sample to 130 mg/L at the outflow site and a reduction of maximum specific conductance values from more than 1,100 microsiemens/centiwater in an inflow sample to 301 microsiemens/centimeter in outflow. The maximum concentration of total nitrogen at inflow sites was 27.0 mg/L compared with 3.2 mg/L at the outflow site. The maximum total phosphorus concentration at inflow sites was 13.0 mg/L compared with 0.6 mg/L at the outflow site. Average annual loads of total nitrogen and total phosphorus in the outflow were as much as 67% and 40% of inflow loads, respectively. Maximum yields at an inflow site were 5.8 t/sq mi (tons per square mile) for nitrogen and 1.4 t/sq mi for phosphorus. Yields of these constituents at the outflow site were 1.5 and 0.2 t/mi, respectively. (USGS) W91-09819

WATER-QUALITY CHARACTERISTICS OF INFLOW TO AND OUTFLOW FROM FALLS LAKE, NORTH CAROLINA, 1982-87. Geological Survey, Raleigh, NC. Water Resources

Div. R. G. Garrett.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4097, 1990. 56p, 12 fig, 8 tab, 13 ref.

Descriptors: \*Falls Lake, \*North Carolina, \*Water quality, Nitrates, Water pollution sources.

Falls Lake, an 11,300-acre reservoir in the northcentral Piedmont of North Carolina, was completed in December 1983. Hydrologic data were collected at seven inflow sites and one outflow site between 1982 and 1987 to define water-quality characteristics. Data include streamflow data and 56 physical and chemical characteristics of stream water. Concentrations of some constituents at inflow sites were as much as 10-to 110-times greater than background concentrations in streams relatively unaffected by man. At the outflow site, these constituents generally were 2-to 3-times greater than background values. The minimum dis oxygen concentration measured at an inflow site was 0.6 mg/L, whereas the minimum concentra-tion measured at the outflow site was 6.7 mg/L. Significant differences in other physical characteristics between inflow and outflow sites include a reduction in maximum concentration of suspended sediment from 1,850 mg/L in an inflow sample to 100 mg/L in an outflow sample, and a reduction of maximum specific-conductance values from more than 1,200 microsiemens/centimeter in an inflow sample to 140 microsiemens per centimeter in the

outflow. The maximum concentration of total nitrogen at inflow sites was 33 mg/L compared with 4.5 mg/L at the outflow site. Similarly, the maximum total phosphorus concentration at inflow sites was 20 mg/L, but 0.22 mg/L at the outflow site. was 20 mg/L, out 0.22 mg/L at the outflow site.
Average annual loads of nitrogen and phosphorus in the outflow were as much as 66% and 21% of inflow loads, respectively. Although maximum inflow yields were 13 t/sq mi for nitrogen and 2.8 t/sq mi for phosphorus, yields of these constituents at the outflow site were about 1.1 and 0.05 t/sq mi, respectively. (TISGS) respectively. (USGS)

EFFECTS OF CHANNEL MODIFICATIONS ON THE HYDROLOGY OF THE CHICOD CREEK BASIN, NORTH CAROLINA, 1975-87. Geological Survey, Raleigh, NC. Water Resources

R. R. Mason, C. E. Simmons, and S. A. Watkins. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4031, 1990. 83p, 16 fig, 20 tab, 46 ref.

Descriptors: \*Channel improvement, \*Groundwater, \*North Carolina, \*Surface water, \*Surfacegroundwater relations, \*Water quality, Chicod Creek basin, Coastal plains.

Drainage modifications in this Coastal Plain basin from 1978 to 1981 consisted of channel excavation from 1978 to 1981 consisted of channel excavation and clearing of blockages. A study was begun in 1975 to define hydrologic conditions of the basin before, during, and after modifications and to determine what changes were attributed to modifications. Surface-water conditions were altered during and following modifications. Minimum flow at Juniper Branch was increased from less than 0.1 cub ft/sec to 0.4 cu ft/second/streamflow than 0.1 Cub II/Sec to 0.4 c ut/second;streamflow variability was reduced from an index of 0.87 to 0.49. In-channel velocity at Chicod Creek was increased from a mean of 0.4 h/sec to 1.5 ft/sec. Substantial groundwater level declines were observed in wells 180 and 250 ft from Juniper Branch when the state of the control during the modifications phase; these were 0.4 and 0.2 ft, respectively. However, most surface-water and groundwater conditions returned nearly to premodification levels by 1987. Water-quality characteristics monitored during the investigation included physical, chemical, and bacteriological characteristics. Physical characteristics monitored were suspended sediment, temperature, dissolved oxygen, and pH. Of these physical characteristics, only sediment concentrations increased substantially during channel modifications. Chemical characteristics studied were major dissolved constituents, nutrients, trace metals, and pesticides. Substantial changes ranged from a decline in total iron concen-trations of 77% to an increase in total nitrite concentrations of 130%. Changes in many chemical characteristics persisted following channel modifications. Bacterial counts did not change substan-W91-09823

RECHARGE RATES AND AQUIFER HYDRAU-LIC CHARACTERISTICS FOR SELECTED DRAINAGE BASINS IN MIDDLE AND EAST TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div.

A. B. Hoos.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4015, February 1991. 34p, 7 fig, 9 tab, 25 ref.

Descriptors: \*Aquifer characteristics, \*Groundwater movement, \*Groundwater recharge, \*Groundwater resources, \*Tennessee, Hydrograph analysis, Recession curve, Specific capacity, Storage coefficient, Transmissivity, Unconfined

Quantitative information concerning aquifer hy-drologic and hydraulic characteristics is poorly defined for the bedrock aquifers in Middle and East Tennessee, where demand for water is in-creasing. This report presents estimates of aquifer

#### Streamflow and Runoff-Group 2E

recharge rates, storage coefficient, diffusivity, and transmissivity for representative drainage basins in Middle and East Tennessee. Aquifer recharge rates are estimated for representative 'high,' 'average,' and 'low' flow years for 63 drainage basins using hydrograph analysis techniques. Net annual re charge during average flow years ranges from 4.1 to 16.8 inches. Estimates of storage coefficient, determined from hydrologic analysis of concurrent water level and streamflow hydrographs for nine drainage basins, range from 0.002 to 0.140. Esti-mates of aquifer hydraulic diffusivity are derived mates of adjuner nydrature influsivity are derived from estimates of the streamflow recession index and drainage density for 75 drainage basins. Values range from 3,300 to 130,000 sq ft/day. Basin-specific and site-specific estimates of transmissivity are computed from estimates of hydraulic diffusivity and specific-canacity tests, respectively. Transmiscomputed from estimates on hydraunic antisovity and specific-capacity tests, respectively. Transmissivity values range from 22 to 1,300 sq ft/day for basin-specific estimates, and from 2 to 93,000 sq ft/day, for site specific estimates. The drainage basins have been grouped according to the underlying major aquifer unit, then statistical descriptions ap-plied to each group, in order to define the areal distribution of these characteristics. (USGS) W91-09833

FLOODS IN WEST VIRGINIA, VIRGINIA, PENNSYLVANIA, AND MARYLAND, NOVEM-

BER 1985.
Geological Survey, Towson, MD. Water Re-

Geological Survey, Towson, MD. Water Resources Div.
D. H. Carpenter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4213, 1990. 86p, 32 fig, 16 tab, 18 ref.

Descriptors: \*Floods, \*Maryland, \*Pennsylvania, \*Virginia, \*West Virginia, Flood damage, Flood recurrence interval, Hydrologic data, Peak dis-

Heavy rainfall from October 31 through November 6, 1985, caused record flooding over parts of West Virginia, Virginia, Pennsylvania, and Maryland. Rainfall exceeded 10 inches over large areas, and. Kamiai exceeded to inches over alge areas, and was as much as 19 inches at one site in the Blue Ridge Mountains. Flooding with a recurrence interval greater than 100 years was measured at 58 gaging stations in the affected region. Peak discharges more than 50% greater than previous peak discharge were recorded at 38 stations. A total of discharge were recorded at 38 stations. A total of 62 lives were lost because of the flooding, and damage was estimated to be \$1,400 million. Damage to the Roanoke-Salem, Virginia, area alone was estimated to be \$440 million. (USGS) W91-09837

WATER-SURFACE PROFILE AND FLOOD BOUNDARIES FOR THE COMPUTED 100-YEAR FLOOD, POPLAR RIVER, FORT PECK INDIAN RESERVATION, MONTANA. Geological Survey, Helena, MT. Water Resources Div.

R. J. Omang.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4169, 1990. 2 sheets, 7 fig, 2 tab, 4 ref.

Descriptors: \*Flood discharge, \*Flood forecasting, \*Flood frequency, \*Flood recurrence interval, \*Montana, \*Poplar River, Flood plains, Flood pro-

Hydrologic and hydraulic evaluations of the Poplar River were made to determine the magnitude of the 100 year flood and the extent of flooding that would occur as the result of this flood. The magnitude of the 100-year flood was determined using data from a streamflow-gaging station on the Poplar River and using techniques devel-oped for predicting flood-frequency information in Montana. Forty-five cross sections were surveyed montana. Forty-tive tross sections were surveyed and 10 cross sections were synthesized along a 37-mile reach of the Poplar River. Data from the surveys were used to calculate water surface elevations at each cross section using a step-backwater computer program (WSPRO) developed by the U.S. Geological Survey in 1986. The water surface

profile of the computed 100-year flood elevations was then drawn for the stream reach studied. The flood profile also shows the streambed elevations and location of bridges and cross sections. The computed 100 year flood elevations at each cross section was used to delineate the width of the flood plain at that section. Flood boundaries between cross sections were interpolated using contour lines on topographic maps. (USGS) W91-09840

STORM-TIDE ELEVATIONS PRODUCED BY HURRICANE HUGO ALONG THE SOUTH CAROLINA COAST, SEPTEMBER 21-22, 1989, Geological Survey, Columbia, SC. Water Resources Div. R. E. Schuck-Kolben.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Open-File Report 90-386, 1990. 23p, 31 plates, 4 fig, 2 tab, 4 ref.

Descriptors: \*Floods, \*High water mark, \*Hurricane Hugo, \*South Carolina, \*Storm surges, \*Tidal floods, \*Water surface profiles, Barrier is-

High-water marks and approximate water surface High-water marks and approximate water surrace contours along the coast of South Carolina caused by the storm surge from Hurricane Hugo on September 21-22, 1989, are presented in a series of 7-1/2 minute topographic quadrangle maps. Three hundred fifteen high water marks from North Myrtle Beach to Seabrook Island were identified in the investigation. The information also is presented to be about the state of the series of the state of the series of the state of the series o in a table that lists the high water mark identification number, quadrangle map, latitude, longitude, type (debris or seed line, inside or outside) and quality of the mark, elevation of water, and ground elevation. These data were also used to construct graphical and tabular estimates of inner-coast and outer-coast surge profiles. (USGS) W91-09841

APPLICATION OF A DISTRIBUTED-ROUT-ING RAINFALL-RUNOFF MODEL TO FLOOD-FREQUENCY ESTIMATION IN SOM-ERSET COUNTY, NEW JERSEY. Geological Survey, Trenton, NJ. Water Resources

Div.
J. L. Fulton.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4210, 1990. 78p, 35 fig, 25 tab, 33 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Floods, \*Flood discharges, Precipitation, Runoff, Somerset County, New Jersey.

The U.S. Geological Survey Distributed-Routing Rainfall-Runoff Model was calibrated for eight basins in Somerset County, New Jersey, using 4 to 5 years of rainfall-runoff data collected at each basin. The drainage areas of the basins modeled range from 3.2 to 13% of the total basin area. Model-verification efficiencies were 75 to 93% for runoff volumes, and 65 to 93% for peak flows. Long term 5-minute storm-precipitation data and daily precipitation data collected at Trenton, New Jersey, were compiled for selected storms. The precipitation data were adjusted to compensate for differences in precipitation between Somerset County and Trenton. These data were used with synthetic evaporation data and the calibrated rainfall-runoff model to synthesize a long-term flood record at each of the eight study basins. The 2-year to 500-year floods were developed for each basin record at each of the eight study basins. The 2-year to 500-year floods were developed for each basin by fitting a log-Pearson Type III distribution to the long-term synthetic peak-flow series. Flood-flow-frequency estimates also were developed using observed peak data in combination with the synthesized peaks series. (USGS) W91-09845

REVIEW OF SELECTED WATER-MANAGE-MENT MODELS AND RESULTS OF SIMULA-TION OBSERVATIONS FOR THE TRUCKEE-CARSON RIVERS SYSTEM, CALIFORNIA AND NEVADA.

Geological Survey, Reston, VA. E. D. Cobb, A. F. Olson, O. Moosburner, and A. Pupacko. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-393, 1990. 40p, 3 fig, 4 tab, 11 ref.

Descriptors: \*Nevada, \*Water rights, \*Water resources development, \*Model studies, \*Truckee River, \*Carson River, \*Pyramid Lake, \*Newlands Project, \*Reno, Water use, Irrigation, Wetlands.

Sierra Pacific, a utility company in the Reno-Sparks, Nevada area and the Pyramid Lake Paiute Indian Tribe have negotiated an agreement for storage of water for use in the Reno-Sparks area during drought periods and for flows in the lower Truckee River at a critical time to improve spawn-Truckee River at a critical time to improve spawning conditions for an endangered species of fish, the cui-ui. Two models of the system are available, the Bureau of Reclamation (BOR) model and the Negotiation model. The Negotiation model was used to study the effects of the Preliminary Settlement Agreement and various amounts of depletions from the upper Truckee River on selected parts of the system. Model analyses project a higher cui-ui index (an index related to the number of adult female cui-ui in Pyramid I ake) with the of adult female cui-ui in Pyramid Lake) with the Preliminary Settlement Agreement in place than without it except when large depletions are made in the upper Truckee River. Large depletions reduce the modeled cui-ui index by 20% to 60% when compared with historical depletions. A prowhen compared with historical depletions. A program is ongoing to purchase water rights in the Newlands Project area for application of water to benefit fish and wildlife in the Lahontan Valley wetlands. According to model simulations, the purchase of 30,000 to 40,000 acre-ft of water rights for application to Lahontan Valley wetlands also results in increases to the cui-ui index by 7,000 to 29,000 and increases the level of Pyramid Lake. (USGS) W91-09849

TURBULENT MIXING AT FRESHWATER/ SALTWATER INTERFACES.

California Inst. of Tech., Pasadena. For primary bibliographic entry see Field 2L.

WATER RESOURCES DATA FOR MINNESO-TA, WATER YEAR 1989, VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN. Geological Survey, St. Paul, MN. sources Div. For primary bibliographic entry see Field 7C. W91-09865

CASE STUDIES IN RURAL GROUNDWATER MANAGEMENT. Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Dept. of Agricultural Economics. W. R. Kerns.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 256-257, 1990.

Descriptors: \*Education, \*Groundwater management, \*Groundwater quality, \*Interagency cooperation, \*Local governments, \*Virginia, Rural

A 10-member Groundwater Protection Steering Committee produced a 79-page document titled A Groundwater Protection Strategy for Virginia' that was released in May 1987. The steering committee consisted of a representative from each state agency with regulatory or educational responsibility in groundwater protection. The strategy document examined current state groundwater protec-tion policies and programs and offered recommen-dations for full implementation of the strategy. The steering committee put a high priority on federal, state and local inputs into educational programs on groundwater quality protection. Overall ground-water protection became the primary issue, rather than individual agency programs. The steering committee contracted with the Virginia Extension Service to conduct a more comprehensive educa-

#### Group 2E—Streamflow and Runoff

tional program that would complement existing efforts by the individual agencies. The committee identified five areas for detailed educational emphasis: underground storage tanks, landfills, lagoons, septic tanks and pesticides and fertilizers. Recent programs have been designed as targeted programs for selected audiences. These programs include: nutrient management for both agricultural teachers and hown see and hown see integrated pesticides. include: nutrient management for both agricultural use and home garden and lawn use; integrated pest management, all uses of pesticides, on-site septical systems, materials for planning officials and other local administrators, and youth education on groundwater. The state steering committee has helped bring groundwater protection concerns to the entire state and to local governmental officials and individual land managers who will be responsible for implementation of the protection strategy. (Author's abstract) (Author's abstract) W91-09886

NUTRIENT LOSS VIA GROUNDWATER DISCHARGE FROM SMALL WATERSHEDS IN SOUTHWESTERN AND SOUTH CENTRAL

Wisconsin Dept. of Natural Resources, Fitchburg.

Bureau of Research.
For primary bibliographic entry see Field 5B.
W91-09905

IDENTIFICATION OF NUTRIENT-LIMITED ALGAL GROWTH IN TWO STREAMS AT

SHILLONG (INDIA).
North-Eastern Hill Univ., Shillong (India). Dept.

J. Rout, and J. P. Gaur. Acta Oecologica, Vol. 11, No. 5, p 631-642, 1990. 4 fig, 3 tab, 33 ref.

Descriptors: \*Algal growth, \*Diatoms, \*India, \*Nutrients, \*Phosphorus, \*Streams, Bioassay, Biomass, Chlorophyll a, Freshwater, Nitrogen, Nutrient concentrations, Species composition.

The Wah Risa and Wah Dienglieng stream in India, completely drain protected forests and are adequately represented with data collected at sampling stations. The streams were found to have low concentrations of nutrient ions throughout the study period, and, therefore, supported depauper-ate algal flora. The existence of a high N:P atomic ratio indicates that phosphorus is a limiting nutri-ent. Laboratory bioassays, with Selenastrum capricornutum as the test organism, confirmed the phosphorus deficient conditions in these streams. The concentration of soluble reactive phosphorus was generally below the level (7 microg/L) considered to be saturating for algal growth. Epilithic algal biomass (chlorophyll a) was low as expected for nutrient deficient soft water streams. (Author's abstract) W91-09989

INFLUENCE OF EXCHANGE FLOW BE-TWEEN THE CHANNEL AND HYPORHEIC ZONE ON NITRATE PRODUCTION IN A SMALL MOUNTAIN STREAM. Geological Survey, Menlo Park, CA. Water Re-

Geological Survey, Menlo Park, CA. Water Resources Div. F. J. Triska, J. H. Duff, and R. J. Avanzino. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2099-2111, November 1990. 13 fig, 1 tab, 43 ref.

Descriptors: \*Channels, \*Groundwater chemistry, \*Hyporheic zone, \*Mountain streams, \*Nitrates, \*Nutrient concentrations, \*Water chemistry, Anoxic conditions, Bioavailability, Channel morphology, Dissolved oxygen, Ecosystems, Flow rates, Hydrology, Lithology, Nitrification, Nutrients, Sediment load, Slurries.

Variation in a local exchange of flows between the Variation in a local exchange of flows between the channel and hyporheic zone produced temporally shifting concentration gradients of dissolved oxygen, nitrate, and ammonium in subsurface waters of a small, gravel-cobble bed stream. Channel water advected laterally supplied dissolved oxygen and groundwater supplied ammonium to oxygen, and groundwater supplied ammonium to support hyporheic nitrification. Nitrate production was highest in sediment slurries from aerobic hy-

porheic sites, was absent at nearly anoxic sites, and was stopped by nitrification inhibitors (chlorate and nitrapyrin). Ammonium amendment to sediment slurries only slightly enhanced nitrate production indicating that sorption competed with biota for available substrate. Nitrate concentrations increased from 75 to 130 microg N/L during 9 days of ammonium amendment to a hyporheic substrate. Flow Ammonium concentrations rose subsurface flow. Ammonium concentrations rose slowly initially relative to a sulfate tracer and declined slowly after cutoff as ammonium desorbed. Nitrate levels remained elevated for 6 days after cutoff as desorbed ammonium became biotically available. Interactions between the channel's hydrology, lithology, and biology observed in nitrate production are probably more common than reported. However, the magnitude of the resulting nutrient flux will depend on factors which determine the depth and lateral extension of suitable hyporheic habitat. (Author's abstract) W91-09993

PERIPHYTON RESPONSES TO HIGHER TROPHIC LEVELS AND LIGHT IN A SHADED STREAM.

Oak Ridge National Lab., TN. Environmental Sci-

ences Div. W. R. Hill, and B. C. Harvey.
Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 47, No. 12, p 2307-2314,
December 1990. 3 fig. 3 tab., 38 ref. US DOE Contract No. DE-AC05-840R21400.

Descriptors: \*Aquatic plants, \*Light effects, \*Peri-phyton, \*Primary productivity, \*Trophic level, Descriptors: "Aquate plants, "Light effects, "Peri-phyton, "Primary productivity, "Trophic level, Aquatic productivity, Biomass, Comparison stud-ies, Fish populations, Light, Productivity, Regres-sion analysis, Snails, Species composition.

The effects of higher trophic levels on benthic primary producers were examined in the context of light limitation in a shaded headwater stream. Abundance (presence or absence) of a predatory fish Semotilus atromaculatus and a grazing snail Elmia clavaeformis were manipulated with in situ Plexiglas channels, while spatial variability in am-Plexiglas channels, while spatial variability in am-bient light was related to variability in primary productivity among channels. Indirect effects of fish on periphyton were insignificant, possibly be-cause grazers that are vulnerable to fish predation were scarce during the experiment, or because fish preyed upon other predators of grazers. Snails had compensatory effects within the periphyton; they diminished biomass and productivity in the loosely attached layer, but stimulated productivity in the ichtly attached layer. Snails angeared to mitigate attached layer, but stimulated productivity in the tightly attached layer. Snails appeared to mitigate shading of the tightly attached layer by the loosely attached layer. Benthic primary productivity was highly correlated with ambient light levels, ac-counting for 42% of the variability in total (loosely and tightly attached layers combined) primary pro-ductivity. Multiple regression analysis indicated that fish and snail effects on total primary produc-tivity were minor compared to light effects. These results suggest abiotic control of both potential and acutal primary production. (Author's abstract) acutal primary production. (Author's abstract) W91-09998

SIMULATION MODELING SYSTEM FOR

AQUATIC BODIES. Akademiya Nauk SSSR, Moscow. Vychislitelnyi Tsentr. For primary bibliographic entry see Field 7B. W91-10008

COMPUTATIONAL HYDROLOGY '87. For primary bibliographic entry see Field 7C. W91-10018

CONFIDENCE INTERVALS FOR FLOODS. California Univ., Irvine. Dept. of Mathematics. For primary bibliographic entry see Field 7C.

APPLICATION OF MICROCOMPUTER PROGRAMS FOR PEAK DISCHARGE CALCULA-

North Carolina Univ. at Charlotte. Dept. of Civil

Engineering. J. S. Wu, and F. C. J. Wu. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A21-A24. 3

Descriptors: \*Computer programs, \*Data interpre-tation, \*Flood peak, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Runoff, \*Urban runoff, Computers, Design storms, Drain-age, Mathematical analysis, Mathematical studies, Rainfall, Storm runoff, Storm

For decades, the prediction of peak discharge for urban drainage design has been based on the use of Rational method and U.S. Soil Conservation Service (SCS) techniques (e.g., TR-20 and TR-55 programs). A review of the latest developments in peak discharge calculation methods evaluated the results obtained using the methods in the analysis of two tyres of design storm distribution (uniform resuits obtained using the methods in the analysis of two types of design storm distribution (uniform and type II storms). Results of the investigation revealed that the peak runoff discharges for type II storms were higher than that from uniform storms, irrespective of the total amount of rainfall and the computational procedures employed. Such a phenomenon was typical for storms of short duration and high intensity. For uniform storms, the Rational method consistently yielded a lower peak runoff rate as compared with the TR-20 method. The use of a constant runoff coefficient in the Rational method caused a uniform deduction of the rainfall amount throughout the runoff period, resulting in lower runoff rates. For type II storms, peak runoff rates computed by the Rational method were gen-erally higher than that of the SCS methods. This phenomenon was more pronounced as the time of concentration was larger than 1 hour. However, the variation of peak runoff rates, as calculated by all three methods, was not significant for time of concentrations less than 1 hour. (See also W91-10018) (Korn-PTT)

COMPLEX WATERSHED MODELS IN FLOOD CONTROL: QUESTIONS OF CREDIBILITY, California State Univ., Fullerton. Dept. of Applied

For primary bibliographic entry see Field 7C. W91-10026

INCLUDING UNCERTAINTY IN HYDROLO-GY CRITERION VARIABLE PREDICTIONS, Williamson and Schmid, Irvine, CA.

For primary bibliographic entry see Field 7C.

FLUVIAL DESIGN OF RIVER BANK PROTECTION FOR SANTA CRUZ RIVER.

San Diego State Univ., CA. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C. W91-10028

URBAN WATERSHED RAINFALL-RUNOFF MODELING: A CASE STUDY, Texas A and I Univ., Kingsville.

For primary bibliographic entry see Field 7C. W91-10029

OPTIMAL DESIGN OF STORM DRAIN SYS-

ASL Consulting Engineers Pasadena, CA. For primary bibliographic entry see Field 4A. W91-10030

APPLICATION OF SMALL AREA UNIT HYDROGRAPH METHOD.

King Civil Engineering Corp., Placentia, CA. For primary bibliographic entry see Field 7C. W91-10031

COMPARISON OF STREAMFLOW ROUTING PROCEDURES FOR HYDROLOGIC MODELS.
California Univ., Davis. Water Resources Center.

For primary bibliographic entry see Field 7C. W91-10033

WATER SURFACE PROFILES IN ICE COV-ERED RIVERS.

Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W91-10038

THEORY FOR DEVELOPMENT OF THE TR-55 TABULAR HYDROGRAPH METHOD. Haestad Methods, Westbury, CT. For primary bibliographic entry see Field 7C. W91-10040

NUMERICAL MODELING OF ARID REGION FLOOD HAZARDS.

nons, Li and Associates, Inc., Newport Beach, D. L. Hamilton, D. R. Schamber, and R. C.

MacArthur. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p F6-F-11. 6 fig,

Descriptors: \*Arid lands, \*Debris flow, \*Flood hazard, \*Flood waves, \*Floods, \*Mathematical models, \*Model studies, \*Mudflows, \*Rheology, Arid-zone hydrology, Bingham fluids, Case studies, Data interpretation, Finite element method, Flood control, Flood plain management, Flood plains, Rudd Creek, Utah.

Floods in the arid regions of the western United States can often be violent and unpredictable. Tra-ditional methods of hydraulic analysis are often inapplicable to flooding due to a lack of defined channel geometry. Frictional resistance terms de-veloped for clear water may not describe the be-havior of mud flows, debris flows or other hyperconcentrated events. A transient, two-dimensional model has been developed for simulating mud and debris flow events. The model is formulated using the basic conservation laws of mass and momen-tum for shallow fluid flow. Since the flows considered are often laminar, a Bingham type resistance equation is incorporated in the model. The governequation is incorporated in the model. The governing equations are solved on a moving grid which tracks the wave front, using the finite element method. Application of the model to the Rudd Creek, Utah, event in the Spring of 1983, delineates the approximate damage zone for this event and reproduces observed depths and velocities. (See also W91-10018) (Korn-PTT)

EFFECT OF DETENTION BASINS ON PEAK WATERSHED DISCHARGES.

Renninger (William) Associates, Greenville, SC. For primary bibliographic entry see Field 4A.

AMERICAN RIVERS GUIDE TO WILD AND SCENIC RIVER DESIGNATION: A PRIMER ON NATIONAL RIVER CONSERVATION. American Rivers, Inc., Washington, DC. K. J. Coyle.

American Rivers, Inc., Washington, DC. 1988.

Descriptors: \*Classification, \*Legislation, \*Rivers, \*Water conservation, \*Wild and scenic rivers, Conservation, Federal jurisdiction, Hydroelectric power, Licenses, River management, Standards, State jurisdiction, Water quality.

The Wild and Scenic Rivers Act is the strongest statutory tool for protecting natural rivers. Dams are forbidden, inappropriate streamside development can be limited and growth better managed, and essential non-utilitarian values are maintained. According to the National Park Service's Nationwide Rivers Inventory, more than 60,000 miles of river qualify for inclusion in the Wild and Scenic Rivers System. But by late 1988, fewer than 9,300 miles enjoyed such protection. The Wild and Scenic Rivers Act has selected provisions worth

noting: Section 1, established the national rivers noung: Section 1, established the national rivers system and sets out the eligibility criteria; Section 2, specifies the two methods by which a river can be designated by act of Congress or by the Secretary of the Interior following state nomination; tary of the Interior following state nomination; Section 3, includes a list of the rivers in the system and their respective beginning and ending points, plus any special provisions; Section 5, contains a list of rivers named by Congress for study under the Act and calls upon federal agencies to consider potential Wild and Scenic Rivers in the prepara-tion of their land and water resource plans; Section 6, authorizes federal government land acquisition of authorizes leueral government land acquisition along rivers but places a number of strict limita-tions on that authority in order to protect the interests of riverside land owners; Section 7, prohibits the Federal Energy Regulatory Comm (FERC) from licensing a hydropower project on a designated river segment or one under study. It also bans the development of any other federal also bans the development of any other federal water resource project or the federal permitting of a state, local, or private project if it would adversely affect the river; Section 9, limits mineral extraction in a designated or study river corridor; Section 10 (among other things) authorizes federal land management agencies to enter into written agreements with state and local governments to jointly manage a river; and Section 11, authorizes the secretaries of Agriculture and Interior to assist state, local, and private groups with river protection of all types. These aspects of Wild and Scenic River study are discussed throughout this handbook. (Lantz-PTT) W91-10064

APPLICATIONS OF SCIENTIFIC MODELING OF HYDROLOGIC RESPONSES FROM HY-POTHETICAL SMALL CATCHMENTS TO ASSESS A COMPLEX CONCEPTUAL RAIN-FALL-RUNOFF MODEL, Washington Univ., Seattle. Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 2B.
W91-10078

ELECTRO-HYDROLOGICAL ANALOGIES.

Polish Academy of Sciences, Warsaw. Inst. of Geophysics. Z. W. Kundzewicz.

W. Aundzewicz.
 Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 55-66, 5 fig., 9 ref.

Descriptors: \*Darcys law, \*Electrical engineering, Descriptors: "Darcys law, "Electrical engineering, "Flow models, "Groundwater movement, "Hydraulic engineering, "Hydrologic models, "Model studies, "Open-channel flow, "Theoretical analysis, Electrical studies, Flow equations, Mathematical analysis, Mathematical models, Numerical analysis, River flow, St Venant equations.

A number of mathematical similarities exist in the A number of mathematical similarities exist in the basic laws governing electrical processes and water movement on a macroscopic or hydrological scale. Electro-hydrological analogies may be made directly through comparison of Darcy's law with Ohm's and Kirchoff's laws of electrical circuit theory. The different mathematical models describtheory. The different mathematical modess describ-ing electrical transmission lines and the process of flow propagation in rivers are strikingly similar; the driving forces of movement are bottom slope, acting similarly to distributed voltage source and lateral inflow acting similarly to distributed current source. In addition to the circuit approach, the transmission line-open channel analogy may also be considered in the field approach by comparing be considered in the field approach by comparing the parameters of the long water waves model (simplified St Venant equations in two dimensions) and the Maxwell equations of electromagnetic waves. There are a number of models developed independently of hydrodynamics, which usually fall into the categories of system (black box, input-output) models or conceptual models. It is evident that the process of charge accumulation in and that the process of charge accumulation in and discharge from a capacitor is similar to the performance of a storage reservoir. The concepts of a linear reservoir and a linear channel are useful elementary hydrological conceptual models which can be modeled with the help of electrical circuits.

#### Streamflow and Runoff—Group 2E

Another electro-hydrological analogy has been used for modeling tidal hydraulics in estuarine channels, relative to an RLC resonance circuit cnannets, retative to an KLU resonance circuit described by an ordinary differential equation of the second order. At present, mathematical equations describing both dynamic hydrologic systems and electrical circuits are conveniently solved on digital computers. (See also W91-10103) (Fish-PTT) W91-10110

STATISTICAL ANALYSIS OF EXTREME EVENTS (ANALYSE STATISTIQUE D'EVENE-MENTS EXTREMES).

Laval Univ., Quebec. Dept. of Civil Engineering.
J. Llamas, R. Charbonneau, and J. C. Rassam.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 77-91, 1 fig, 8 tab, 19 ref. English

Descriptors: \*Extreme events, \*Flood forecasting, \*Mathematical studies, \*Maximum probable floods, \*Statistical analysis, \*Statistical methods, \*Statistics, Flood data, Flood recurrence interval, Model studies, River flow, Statistical models

The statistical analysis of some hydrological varia-bles such as river discharge, and precipitation, is often restricted to one specific aspect: the extreme often restricted to one specific aspect: the extreme values. If the historical samples are sufficient, the adjustment of classical distribution curves permits the evaluation of those values outside the sample domain. In this manner, floods having return periods of 100, 1,000, and 10,000 years can be estimated. ed. Most of the functions used for evaluation of maximum values of hydrologic variables are unbounded, at least above. However, variables such as river flow have in fact a real physical upper as river flow have in fact a real physical upper limit as well as a lower one. The upper limit is called the maximum probable flood (MPF) and, under this hypothesis, the adjustment should be limited to curves of the beta family. Several rivers for which sufficient records are available have been analyzed in order to evaluate their MPF. Then, floods with high return period were estimat-ed by several methods: classical methods (log-Pearson III, Pearson III, and Gumbel); methods using high order parameters (maximum entropy. using high order parameters (maximum entropy distribution); and using beta approximation with MPF bound. (See also W91-10103) (Author's abstract) W91-10112

ROLE OF QUANTITATIVE GEOMORPHO-LOGY IN THE HYDROLOGICAL RESPONSE OF RIVER NETWORKS.

Water Resources Research and Documentation Centre, Villa La Colombella, 06080 Colombella,

Perugia, Italy.
K. Andah, R. Rosso, and A. C. Taramasso.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 93-110, 3 fig, 2 tab, 49 ref.

Descriptors: \*Drainage patterns, \*Geomorphology, \*Hortons law, \*Model studies, \*Stream classification, \*Streamflow forecasting, Drainage systems, Chana, Hydrologic models, Italy, Regional analysis, River basins, River systems.

Although many drainage network schemes based on Horton's stream ordering have been developed and used in many studies, there has not emerged any one model that answers to the complex influences of the controlling variables of climate, hydrology, vegetation cover, and soil characteristics.

Analysis of various schemes shows that these schemes tend to put more emphasis on individual physical processes than to address the actual phephysical processes than to adures the actual phenomenon involving the mutual interactions between the hydrological and geomorphological characteristics and the drainage network structure. An analysis of the physical milieu defining the drainage network structure has been carried out using data from river networks in Ghana (regional analysis) they are the process of the control o analysis) and Italy (single basin analysis), showing the interconnections between the various ordering

#### Group 2E-Streamflow and Runoff

schemes. For the regional analysis, it was observed that the relationships of stream lengths and stream drainage area/length ratio with stream order change at the sixth order, except for streams in flat plains in the case of area length ratio. The hydro-graphical characteristics are dependent on the phy-sicogeographical conditions of the drainage basin, especially on basin relief. When compared with traditional regression analysis, regional analysis based on stream ordering seems to provide better results as far as the reliability of the estimates are concerned. In the single basin analysis, the relationships of the mean values of stream lengths and stream slopes with order changed at the fourth and fifth orders with respect to the lag-one cumulative effect. The values of discharge ratios seem to indicate their tendency to increase from higher time-averaged values to instantaneous rather than the flow states. The Hortonian stream-order approach paves the way for understanding the hydrological response of the network structure at the basin scale. (See also W91-10103) (Fish-PTT) W91-10113

MULTIVARIATE EXTREME VALUE DISTRI-BUTIONS IN HYDROLOGICAL ANALYSES.

Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria. For primary bibliographic entry see Field 7C. W91-10114

SOME REMARKS ON REAL TIME FLOOD FORECASTING BY SIMPLIFIED SEMI-DISTRIBUTED MODELS.

Consiglio Nazionale delle Ricerche, Perugia (Italy). Ist. di Ricerca per la Protezione Idrogeolo-gica nell' Italia Centrale. C. Corradini, F. Melone, and L. Ubertini.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 121-127, 3 fig, 8 ref.

Descriptors: \*Flood forecasting, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Runoff forecasting, Effective precipitation, Flow equations, Infiltration, Italy, Parametric hydrology, River basins, Unit hydrographs.

In the scientific literature the possibility of selecting simple adaptive models for real time flood forecasting has been widely discussed. The reliability of two simple on-line flood forecasting models has been investigated. These adaptive rainfall-runoff models of the semi-distributed type provided reasonable flood predictions for a large basin with mean lag time of 18 h and forecast lead times up to 6 h. Both models consider variability in space of rainfall and losses and incorporate the undating of rainfall and losses and incorporate the updating of flow forecasts at each time step, substantially through the correction of one parameter involved in the description of losses. In the RS model, mean in the description of losses. In the RS model, mean areal depth of effective rainfall is corrected; in the CM model, the major loss is assumed to be infiltration. These two models and the unit hydrograph-based adaptive model were applied to the Upper Tiber River basin in central Italy. As supported by the analysis of the evolution in time of the adaptive parameters, in addition to the computed accuracy in flow forecasts, the CM model seems to be substantially more appropriate than the RS model for further developments of the investigated modfor further developments of the investigated mod-eling. The RS model could be usefully employed for on-line flood forecasting in view of its ease of application. However, on the basis of the wide range of variability computed for the adaptive parameter and determined by the simplified representation of the processes involved, the model should be tested on a wide variety of basins. The unit hydrograph-based adaptive model represents an over-simplified approach for real-time flood forecasting in large basins. Adaptiveness is usually not sufficient to correct for the synthetic representation of the rainfall-runoff process. Simplified semi-distributed models have much to offer for future flood forecasting schemes in areas where data may be limited. (See also W91-10103) (Fish-W91-10115

EVALUATION OF PARSIMONIOUS STO-CHASTIC MODELS FOR RUNOFF FORE-CASTING AND SIMULATION IN TROPICAL ENVIRONMENTS, ZAMBIA.

Department of Water Affairs, Maseru (Lesotho).

Snarma.
 Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 129-141, 5 fig. 2 tab, 9 ref.

Descriptors: \*Hydrologic models, \*Model studies, Descriptors: "Hydrologic models, "Model studies, Rainfall-runoff relationships, "Runoff forecasting, "Stochastic models, "Zambia, Correlation analysis, Simulation analysis, Stochastic hydrology, Tropi-cal regions, Water resources management.

Runoff forecasting and simulation is likely to occupy a key position in the overall strategy of managing the surface water resources of the Kafue basin. Zambia. The abilities of the univariate stochastic runoff model comprised of harmonic and/ or autoregressive moving average components, and discrete dynamic lumped linear rainfall-runoff (bivariate) model were examined for forecasting and simulation of runoff sequences in Zambian drainage basins. It was concluded that the bivariate monthly rainfall-runoff model consisting of first-order memory terms in the runoff and in the rainfall processes appeared reliable for one-month-ahead adaptive forecasting. The univariate parsi-monious model consisting of harmonic and automonious moute consisting of harmonic and according to the regressive moving average components must be ranked second. None of these models appeared reliable for 12-months-ahead forecasting. Neither the univariate stochastic model nor the bivariate rainfall-runoff model provided a reliable simulation of the monthly discharge sequences. Major discrepancies were encountered in simulating the correlations in the flow sequences of adjacent months serial correlations) and among the runoff sequences of a particular month (autocorrelations). However, the univariate model containing eight parameters preserved means and coefficients of parameters preserved means and coefficients of variation better than those provided by the bivar-iate model consisting of five parameters. On a yearly basis, the univariate stochastic model showed promise in simulating the yearly runoff sequences. (See also W91-10103) (Fish-PTT) W91-10116

HYDROLOGICAL NETWORK BASED ON AN INSTRUMENT FOR AUTOMATIC TIME-VARIABLE DATA ACQUISITION.

Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology. For primary bibliographic entry see Field 7A. W91-10117

RIVER MECHANICS: A UNIVERSAL AP-PROACH.

PROACH.
Rand Afrikaans Univ., Johannesburg (South Africa). Systems Lab.
G. W. Annandale.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 161-167, 4 fig, 1 tab, 16 ref.

Descriptors: \*Channel morphology, \*Channel sta-bility, \*Chaos theory, \*Entropy, \*Geomorpho-logy, \*River mechanics, \*Stream classification, \*Streamflow, Braided streams, Channel flow, Sta-bility analysis, Stable channels.

The theories of chaos and minimization of internal entropy production may be used to argue that river behavior is comparable to the behavior of any other physical system. An attempt has been made to show that the progression from stability (in the case of straight river channels) to chaos (in the case of braided streams) is the same as that followed in the case of systems in fluid mechanics, electronics, chemistry, optometry, and biology. Stream power is an alternative means of expressi internal entropy production at a specified tempera-ture and can therefore be used as a nonlinear parameter in the correlation of the theory of chaos with the observations of the qualitative relationship between channel patterns, relative stability, and sediment and flow properties. If the measure

of stability of a river is taken as the position of flow in the direction transverse to the general direction of flow, qualitative analysis indicates that low values of stream power are associated with a single stable value as a function of time; whereas high values of stream power are associated with unstable situations. Further research following this universal approach should enable scientist and engineers to obtain a better understanding of river mechanics. (See also W91-10103) (Fish-PTT) W91-10119

STUDY OF HYDROLOGICAL REGIMES IN EXPERIMENTAL BASINS IN RELATION TO CULTIVATION PRACTICES.

Institutul de Meteorologie si Hidrologie, Bucharest (Romania). For primary bibliographic entry see Field 2B.

W91-10122

KARST HYDROLOGY AND WATER RE-SOURCES--PAST, PRESENT, AND FUTURE. Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
For primary bibliographic entry see Field 2F. W91-10123

HYDROCLIMATIC CONSEQUENCES OF CLIMATIC EVENTS IN WEST AFRICA: THE LESSONS OF THE 1969-1984 SAHELIAN DROUGHTS.

Lagos Univ. (Nigeria). Dept. of Geography. For primary bibliographic entry see Field 2B. W91-10125

TECHNICAL COOPERATION BETWEEN ITALY AND CHINA FOR THE IMPROVEMENT OF FLOOD FORECASTING.

C. Lotti & Associati, Via del Fiume 14 (passeggiata di Ripetta), 00186 Rome, Italy.

A. Gabos, and W. J. Mou. IN: Water for the Future: Hydrology in Perspec tive. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 245-251, 1 fig, 1 ref.

Descriptors: \*China, \*Flood forecasting, \*Hydrologic data, \*Hydrologic models, \*International coperation, \*Italy, \*Model studies, \*Technology transfer, Computer models, Evaporation, Hydrographs, Hydrologic data collections, Precipitation, Runoff, Statistical analysis, Unit hydrographs.

The Hydrological Centre in Beijing, China, has the vital role in real time flood forecasting for the major rivers of China. Within the framework of technical cooperation, an improvement program was started in 1982. The project included the dewas started in 1982. The project included the development of the necessary software and the installation of two pilot telemetering networks and two computer centers. Upon completion of the project, the data collection and processing system was then improved and extended. An additional training course was carried out in Rome, Italy, with the purpose of improving the flood forecasting model. The hydrological forecasting model completed during the training course represents an original combination of conceptual and statistical modeling techniques. The conceptual part contains a runoff production mechanism based on the tension water storage and an evaporation accounting mechanism based on a three layer free water storage scheme. based on a three layer free water storage scheme. The statistical model, known as Constrained Linear System (CLS), computes the outflow hy-drograph as the sum of the linear responses of a series of hydrological inputs. There are three phases in the system, each related to computer programs: the study area is subdivided into sub-basins, each calibrated separately; then the calibra-tion file and the state matrix file is created; from these two files and the hydrological data the discharge at the downstream section is computed. The sub-basins can have one or more hydrological inputs, either discharges or precipitation. Two or three unit hydrographs are computed, according to the type specified. Although some success has been achieved in China, it is necessary to further devel-op the means of provision of hydrological informa-

## Groundwater—Group 2F

tion and methods of forecasting. (See also W91-10103) (Fish-PTT) W91-10127

FUTURE OF RAINFALL-RUNOFF MODEL-LING IN ARID AREAS--LAKE EYRE CASE STUDY.

South Australian Dept. of Engineering and Water Supply, Adelaide. For primary bibliographic entry see Field 2B. W91-10135

MODELLING THE INFLUENCE OF LAND USE CHANGE ON FLOOD FLOWS. Ruhr Univ., Bochum (Germany, F.R.). For primary bibliographic entry see Field 4C. W91-10138

RESEARCH NEEDS IN CATCHMENT DIS-TRIBUTED MODELLING.

Bristol Univ. (England). Dept. of Geography. C. C. M. Rogers, and M. G. Anderson. IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 415-423, 1 fig, 11 ref. NERC Grant GR3/4840.

Descriptors: \*Hydrologic models, \*Model studies, \*Research priorities, \*Spatial distribution, \*Watersheds, Calibrations, Catchment areas, Distribution, Gaging, Hydrographs, Parametric hydrology, Streamflow data.

Distributed hydrological models describe numerous field processes in a spatial context and there-fore have very great relevance to current research in physical hydrology. A number of directions for future research have been identified for the hydro-logical distributed model, which treats a catchment logical distributed model, which treats a catchment as a spatially variable system with input variables, parameters, and predictions which are dependent on their location. The model equations are physically based so that the variables and parameters are ultimately intended to be measurable in the field. Many types of applications of hydrological models require hydrograph predictions, which require calibrations to determine values for selected parameters. The restrictions imposed by parameters quire canorations to determine values for selection parameters. The restrictions imposed by parameter calibration may be such that the full potential of utilizing physically based parameters cannot be realized; some form of spatial averaging of the parameters in needed which may constrain the model process behavior. Distributed models can be used to address essentially ungaged basin problems, including: applications to catchments for which no data are available; the available data are of a general form only, without specific values; the absence of streamflow data only; restricted availability of of streamflow data only; restricted availability of streamflow measurements; applications to land use change (essentially ungaged); and prediction of streamflow from and ungaged subcatchment which is part of a gaged basin. Present restrictions on applications of distributed models are primarily concerned with calibration and validation. Key concerned with calibration and validation. Key research areas include the need to validate such models at the catchment and hillslope scales, the problems of model design, and the need for further research applications. The high level of model complexity renders discussion of this type more essential than hitherto, if a sound research design comprising both model development and application are to be achieved. (See also W91-10103) (Fish-PTT) (Fish-PTT)

PARAMETER DETERMINATION AND INPUT ESTIMATION IN RAINFALL-RUNOFF MOD-ELLING BASED ON REMOTE SENSING

TECHNIQUES.
Ruhr Univ., Bochum (Germany, F.R.).
For primary bibliographic entry see Field 2B.
W91-10142

STRUCTURE AND DYNAMICS OF MANGROVE FORESTS ALONG A FLOODING GRA-DIENT

Universidad Nacional Autonoma de Heredia

(Costa Rica). Escuela Ciencias Biologicas. For primary bibliographic entry see Field 2L. W91-10175

MEASUREMENT OF CURRENT VELOCITIES IN MACROPHYTE BEDS.
Vienna Univ. (Austria). Inst. fuer Pflanzenphysio-

logie. For primary bibliographic entry see Field 7B. W91-10202

DISTRIBUTION AND FLUXES OF METALS IN THE ST. LAWRENCE RIVER FROM THE OUTFLOW OF LAKE ONTARIO TO QUEBEC

Direction, Ecotoxicologie et Ecosystemes, Centre St. Laurent, 105 rue McGill, Montreal H2Y 2E7, Quebec, Canada.

For primary bibliographic entry see Field 5B. W91-10213

EFFECT OF TEMPERATURE, SEASON, AND FISH SIZE ON ACUTE LETHALITY OF SUSPENDED SEDIMENTS TO COHO SALMON (ONCORHYNCHUS KISUTCH).

Department of Fisheries and Oceans, Cultus Lake (British Columbia). Cultus Lake Salmon Research

For primary bibliographic entry see Field 2H. W91-10223

EFFECT OF ENVIRONMENTAL PH ON THE HEPATIC MIXED FUNCTION OXIDASES IN ATLANTIC SALMON (SALMO SALAR). Bedford Inst. of Oceanography, Dartmouth (Nova For primary bibliographic entry see Field 5C.

W91-10225

EFFECTS OF MOOSE BROWSING ON DE-COMPOSITION RATES OF BIRCH LEAF LITTER IN A SUBARCTIC STREAM. Alaska Univ., Fairbanks. Inst. of Arctic Biology. For primary bibliographic entry see Field 2H. W91-10226

ADRENERGIC RESPONSE TO PHYSIOLOGI-CAL DISTURBANCES IN RAINBOW TROUT, ONCORHYNCHUS MYKISS, EXPOSED ALUMINUM AT ACID PH.

Centre d'Etude de l'Energie Nucleaire, Mol (Belgium). Lab. for Mineral Metabolism.
For primary bibliographic entry see Field 5C. For primary bibliographic entry see Field 5C. W91-10227

INITIAL FEEDING TIME OF ATLANTIC SALMON, SALMO SALAR, ALEVINS COMPARED TO RIVER FLOW AND WATER TEMPERATURE IN NORWEGIAN STREAMS. Direktoratet for Vilt og Ferskvannsfisk, Trond-For primary bibliographic entry see Field 2H. W91-10229

IMPORTANCE AND EFFECTS OF SEASONAL SNOW COVER.

Eidgenoessisches Inst. fuer Schnee- und Lawinenforschung, Davos (Switzerland). For primary bibliographic entry see Field 2C. W91-10348

LARGE SCALE EFFECTS OF SEASONAL SNOW COVER AND TEMPERATURE INCREASE ON RUNOFF.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.

For primary bibliographic entry see Field 2B. W91-10349

ESTIMATES OF POSSIBLE VARIATIONS OF SNOWMELT-RUNOFF CHARACTERISTICS AND CLIMATIC CHANGES,

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh

For primary bibliographic entry see Field 2B. W91-10350

METHOD OF INDEXING THE VARIABILITY OF ALPINE SEASONAL SNOW OVER LARGE

AREAS.
Otago Univ., Dunedin (New Zealand). Dept. of Geography.
For primary bibliographic entry see Field 2C. W91-10351

MODELLING LARGE SCALE EFFECTS OF SNOW COVER, British Columbia Univ., Vancouver.

For primary bibliographic entry see Field 2B. W91-10352

SNOWMELT-RUNOFF SIMULATION MODEL OF A CENTRAL CHILE ANDEAN 3ASIN WITH RELEVANT OROGRAPHIC EFFECTS. Direccion General de Aguas, Santiago (Chile). For primary bibliographic entry see Field 2C. W91-10353

UTILITY OF COMPUTER-PROCESSED NOAA IMAGERY FOR SNOW COVER MAPPING AN STREAMFLOW SIMULATION IN ALBERTA. Alberta Environment, Edmonton. For primary bibliographic entry see Field 2C. W91-10354

SNOW COVER AREA (SCA) IS THE MAIN FACTOR IN FORECASTING SNOWMELT RUNOFF FROM MAJOR RIVER BASINS. National Remote Sensing Agency, Hyderabad (India). Hydrology Div. For primary bibliographic entry see Field 2C. W91-10355

MODELLING OF SNOWMELT DISTRIBU-TION FOR THE ESTIMATION OF BASIN-WIDE SNOWMELT USING SNOW COVERED AREA.

Tokyo Univ. (Japan). Dept. of Civil Engineering. For primary bibliographic entry see Field 2C. W91-10356

MODELLING THE EFFECTS OF AGROTECH-NICAL MEASURES ON SPRING RUNOFF AND WATER EROSION,

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem. For primary bibliographic entry see Field 2C. W91-10359

INFLUENCE OF THE VARIABILITY OF SNOW COVER THICKNESS ON THE INTENSITY OF WATER YIELD AND DURATION OF SPRING FLOOD ON A SMALL RIVER. Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).

For primary bibliographic entry see Field 2A. W91-10360

INTEGRATION OF DIGITAL TERRAIN MODELS INTO GROUND BASED SNOW AND RUNOFF MEASUREMENT. Saskatchewan Research Council, Saskatoon

For primary bibliographic entry see Field 2C. W91-10370

## 2F. Groundwater

DRAINAGE OF CLAY OVERLYING ARTE-SIAN AQUIFER, I: HYDROLOGIC ASSESS-

California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 4A. W91-09397

## Group 2F-Groundwater

DRAINAGE OF CLAY OVERLYING ARTE-SIAN AQUIFER, II: TECHNICAL ANALYSIS. For primary bibliographic entry see Field 4A. W91-09398

PENDIMETHALIN DISSIPATION IN KEN-TUCKY BLUEGRASS TURF.

Nebraska Univ., Lincoln. Dept. of Horticulture. For primary bibliographic entry see Field 5B.

CONTAMINATION OF GROUNDWATER BY ATRAZINE AND SELECTED METABOLITES. Agricultural Research Service, University Park, PA. Northeast Watershed Research Center. For primary bibliographic entry see Field 5B.

GROUNDWATER GEOCHEMISTRY AND RADIONUCLIDE ACTIVITY IN THE CAMBRIAN-ORDOVICIAN AQUIFER OF DODGE AND FOND DU LAC COUNTIES, WISCONSIN.

Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.

T. R. Weaver, J. M. Bahr, and M. P. Anderson. Available from National Technical Information Service, Springfield, VA 22161 as PB91-111534/ AS. Price codes: A05 in paper copy, A05 in microfiche. Technical Report WIS WRC 90-01, 67p, 26 fig, 2 tab, 36 ref. USGS Contract No. 14-08-0001-G1458. USGS Contract No. G1458-02.

Descriptors: \*Aquifers, \*Confined aquifers, \*Geochemistry, \*Model studies, \*Radioisotopes, \*Radiom, \*Sandstones, Chemical analysis, Finite difference models, Groundwater, Groundwater movement, Flow models, Ionic studies, Wells, Wisconsin

Analyses of groundwater from wells in the Cambrian-Ordovician aquifer of eastern Wisconsin indi-cate that regions of this aquifer contain elevated concentrations of dissolved solids, chloride and sulfate. Groundwater from several wells in this area also approach or exceed the current drinking water standard for combined radium activity. Significant changes in groundwater chemistry occur where the aquifer becomes confined by the Ma-quoketa shale. Concentrations of Cl(-), SO4(2-) and Na(+) increase in the confined region, and the highest combined radium activities are typically observed in this area. Geochemical modeling imobserved in this area. Geochemical modering in-plies that the observed changes in major ion groundwater chemistry occur in response to the presence of the confining unit which may act as a source of SO4(2-), through gypsum dissolution, and Na(+), through cation exchange. The relief of the Precambrium surface, inferred from geological the Precambrium surface, interred from geological logs, also affects the groundwater chemistry in the confined region, allowing high Cl(-) concentrations to develop in regions of low flow at the base of the aquifer system. A finite difference groundwater flow model was linked to a particle tracking souther to determine groundwater flow paths and routine to determine groundwater flow paths and residence times in the aquifer near the boundary between unconfined and confined conditions. Rebetween unconfined and confined conditions. Re-sults suggest that the presence of the confining unit produces a vertically stratified flow regime in the confined region. Groundwater in the shallow por-tion of the aquifer below the confining unit is derived primarily from recharge through the over-times the lead delowing formst time at heir server. lying shale and dolomite formations and horizontal flow from the unconfined region in the upper sandstone formation. The high Na(+) and SO4(2-) concentrations observed in this region support the concentrations observed in this region support the conclusion that a significant input of groundwater occurs from the overlying shale. Groundwater flow in the deeper portion of the confined region is predominantly horizontal, derived from the upgradient, unconfined region. Input of groundwater from formations directly overlying the lower sandstones is limited. Groundwater in the unconfined region is unconfined to the confined region is vertically mixed, allowing more recently recharged waters to penetrate the entire aquifer system. This results in homogeneous groundwater chemistry in this region. (Sherman-WiWRC) W91-09470

MASS TRANSPORT IN THE DISTRIBUTED SOURCE MODELING PROBLEM.

Water Resources Research Inst., Lex-Kentucky ington.

For primary bibliographic entry see Field 5B.

SUMMARY OF DATA FROM THE 1981-83 PILOT STUDY AND 1985-89 OPERATIONS OF THE HUECO BOLSON RECHARGE PROJECT, NORTHEAST EL PASO, TEXAS.

Massachusetts Inst. of Tech., Cambridge. Microsystems Technology Labs.
For primary bibliographic entry see Field 4B.

PHYSICAL AND CHEMICAL DATA FOR GROUND WATER IN THE MICHIGAN BASIN,

Geological Survey, Lansing, MI. Water Resources Div.

G. T. Dannemiller, and M. A. Baltusis. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-368, 1990. 163p, 3 fig, 47 tab,

Descriptors: \*Geohydrology, \*Groundwater, \*Groundwater basins, \*Isotopes, \*Michigan, \*Michigan basin, \*Regional Aquifer System Anal-ysis, \*Water chemistry, Bayport Limestone, Berea Sandstone, Chemical analysis, Glacial deposits, Grand River Formation, Marshall Sandstone, Michigan Formation, Parma Sandstone, Saginaw Formation, Shales, Water analysis.

Ground-water samples were collected from 459 wells in 46 counties in the central part of the Michigan basin as part of the U.S. Geological Survey's Regional Aquifer-Systems Analysis. Physical and chemical data of 476 ground-water rnysical and chemical data of 476 ground-water samples from these wells represent characteristics of water from wells open to the Berea Sandstone, Coldwater Shale, Marshall Sandstone, Michigan Formation, Bayport Limestone, Saginaw Formation, Grand River Formation, and glacial deposits. The data are presented in tables, organized by county. Groundwater samples were measured in county. Groundwater samples were measured in the field for specific conductance, temperature, and alkalinity. Analyses of groundwater for con-centrations of dissolved oxygen, ferrous iron, total iron, and sulfide were also done in the field. Addiitional laboratory analysis provided data on eight major and 18 minor inorganic constituents. Twenty-one samples were analyzed for tritium, 140 samples were analyzed for the ratio of carbon 140 samples were analyzed for the ratio of carbon-13 to 12, and 19 samples were analyzed for carbon-14. The stable-isotope ratio of deuterium to hydro-gen was determined for 408 samples; the ratio of oxygen-16 was determined for 433 samples; and the ratio of sulfur-34 to sulfur-32 was determined for 20 samples. Sixteen samples were analyzed for the unstable isotopes of uranium; 13 samples were analyzed for radium-226; and the ratio of radium-228 to radium 226 was determined for 13 samples. Individual county maps of the area show the loca-tion of the data-collection sites within the study area. (USGS) W91-09484

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CONTAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS

Geological Survey, Tucson, AZ. Water Resources For primary bibliographic entry see Field 5B.

POTENTIOMETRIC SURFACE OF THE IN-TERMEDIATE AQUIFER SYSTEM, WEST-CENTRAL FLORIDA, MAY 1990. Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 7C.

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, WEST-CENTRAL FLORIDA, MAY 1990.

Geological Survey, Tampa, FL. Water Resources Div.

For primary bibliographic entry see Field 7C.

GROUND-WATER CONDITIONS IN THE GRAND COUNTY AREA UTAH, WITH EMPHASIS ON THE MILL CREEK-SPANISH VALLEY AREA.

Geological Survey, Salt Lake City, UT. Water Resources Div.

P. J. Blanchard.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Utah Dept of Natural Resources, Div of Water Rights, Salt Lake City, Technical Publication No. 100, 1990. 69p, 24 fig, 11 tab, 2 pl, 29 ref.

Descriptors: \*Aquifer characteristics, \*Geohydrology, \*Grand County, \*Groundwater reservoirs, \*Utah, \*Water resources data, Dissolved solids, Groundwater availability, Radiochemical analysis, Selenium, Trace elements

Groundwater conditions were evaluated in bed-Groundwater conditions were evaluated in bedrock aquifers in Grand County and parts of northern San Juan County, Utah. Special emphasis was
given to the aquifers in the Entrada, Navajo, and
Wingate Sandstones, and to the Glen Canyon aquifer in the Mill Creek-Spanish Valley area. Springs
and flowing wells producing water from the Cedar
Mountain Formation and the Brushy Basin Shale
and Salt Wath Sandstone Members of the Morriand Salt Wash Sandstone Members of the Morrison Formation locally discharge slightly saline son Formation locally discharge freshwater at rates typically less than I gal/min. Springs issuing from the Entrada, Navajo, and Wingate Sandstones locally discharge freshwater through gal/min. Wells drilled in the Cutler Formation on the west side of Castle Valley produce slightly saline to moderately saline water at rates of about 1 to 40 gal/min, and the water typically has concentrations of selenium larger than the State of Utah's primary drinking-water standard of 10 microg/L. In the City of Moab well field, spring and well discharges from the Glen Canyon aquifer reportedly are as large as 390 gal/min and 2,000 gal/min, respectively, and concentrations of dissolved solids are typically less than 200 mg/L. The largest discharges are from the fractured rocks of the Glen Canyon aquifer. Small concentrations of dissolved solids similar to values for water in recharge areas sonus similar to values for water in recange areas are the result of groundwater moving into the area primarily from outcrops of the Glen Canyon Group to the east. West and south of the city of Moab well field, the concentrations of dissolved solids and sulfate increase as the ratio of water from the outcrop area to water from farther up Spanish Valley decreases. (USGS) W91-09492

POTENTIOMETRIC SURFACE OF THE ED-WARDS-TRINITY AQUIFER SYSTEM AND CONTIGUOUS HYDRAULICALLY CONNECT-ED UNITS, WEST-CENTRAL TEXAS, WINTER

Geological Survey, Austin, TX. Water Resources Div.

For primary bibliographic entry see Field 7C.

GROUND-WATER RESOURCES AND SIMULATED EFFECTS OF WITHDRAWALS IN THE EAST SHORE AREA OF GREAT SALT LAKE,

Geological Survey, Salt Lake City, UT. Water Resources Div. D. W. Clark, C. L. Appel, P. M. Lambert, and R.

L. Puryear.

L. Puryear.

Available from Utah Department of Natural Resources, 1636 West North Temple, Salt Lake City, Utah, 84116. Utah Department of Natural Resources Technical Publication 93, 1990. 150p, 67 fig, 13 tab, 1 plate, 43 ref.

## Groundwater-Group 2F

Descriptors: \*Geohydrology, \*Groundwater, \*Groundwater movement, \*Groundwater resources, \*Model studies, \*Utah, \*Water quality, \*Water resources data, \*Water table decline, Artesian wells, Canal seepage, Hydraulic properties, Hydrographs, Potentiometric level, Recharge,

The groundwater resources in the East Shore area of Great Salt Lake, Utah, were studied to document changes in groundwater levels, quality, and storage. A numerical model was used to simulate effects of increased groundwater withdrawals. The East Shore aquifer system is in basin-fill denosits. East Shore aquifer system is in basin-fill deposits, and is primarily a confined system with unconfined parts near the main mountain front. Recharge to parts near the main mountain front. Recharge to and discharge from the East Shore aquifer system were estimated to average about 160,000 acre-ft/yr during 1969-84, with minor amounts of water being removed from storage. Major sources of recharge are seepage and subsurface inflow from consolidated rock; discharge is primarily to wells, water courses, springs, and as diffuse seepage to Great Salt Lake. Average annual surface-water inflow to the study area was estimated to be 860,000 acre-ft for the period 1969-84. Water level trends of groundwater levels indicate a steady decline at most observation wells since 1952, despite near normal or increased precipitation since the late 1960's. Water levels declined as much as 50 ft near the principal pumping center. A numerical model of the East Shore aquifer system in the Weber Delta area was used to simulate effects of doubling withdrawals for municipal and industrial use for 20 yrs and using both average and below-average recharge rates. Simulations indicated water level rectarge rates. Simulations indicated water level declines of an additional 35 to 50 ft near the principal pumping center; a decrease in natural discharge, and a decrease in groundwater storage of 80,000 to 115,000 acre-ft. (USGS) W91-09498

HYDROLOGICAL, METEOROLOGICAL AND GEOHYDROLOGICAL DATA FOR AN UNSATURATED ZONE STUDY NEAR THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO-1987.

Geological Survey, Idaho Falls, ID. Water Re-

sources Div.

L. C. Davis, and J. R. Pittman Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-114, 1990. 208p, 17 fig, 38 tab,

Descriptors: \*Geohydrology, \*Groundwater movement, \*Idaho, \*National Engineering Labora-tory, \*Path of pollutants, \*Radioactive waste disposal, \*Radioactive wastes, \*Radioisotopes, \*Un-saturated zone, Grain-size analysis, Measuring instruments, Meteorology, Net recharge, Soil water potential, X-ray diffraction.

Since 1952, radioactive waste has been buried at the RWMC (Radioactive Waste Management Complex) at the Idaho National Engineering Laboratory in southeastern Idaho. In 1985, the U.S. Geological Survey, in cooperation with the U.S. Geological Survey, in cooperation with the U.S. Department of Energy, began a study of the geo-hydrology of the RWMC to provide a basis for estimating the extent of and the potential for migration of radionuclides in the unsaturated zone beneath the waste burial trenches and pits. This study is being conducted to provide hydrological, meteorological and geohydrological data for the test trench area adjacent to the northern boundary of the RWMC. During 1987, data were collected from the test trench area where several types of from the test trench area, where several types of instrumentation were installed in the surficial sediment in 1985. Hydrological data collected from both disturbed and undisturbed soil included measurements, recorded hourly and averaged every 12 hrs, of soil temperature and soil water potential from 28 thermocouple psychrometers placed at selected depths to about 6m. Soil moisture content measurements were collected bi-weekly in 9 neumeasurements were conceted between in 9 learners in 10 learners in 10 learners included; (1) incoming and emitted long-wave radiation; (2) incoming and reflected short-wave radiation; (3) incoming and reflected short-wave radiation; (4) incoming and reflected short-wave radiation; (5) incoming and reflected short-wave radiation; (6) incoming and reflected short-wave radiation; ation; (3) air temperature; (4) relative humidity; (5)

wind speed; (6) wind direction; and (7) precipitation. To describe grain-size distribution with depth, 17 samples were analyzed using sieve and pipette methods. Statistical parameters, carbonate content, color, particle roundness and sphericity, and mineralogic and clastic constituents were determined for each sample. Some samples were analyzed by x-ray diffraction techniques to determine bulk and clay mineralogy. (USGS)
W91-09499

GROUND-WATER DATA FOR THE PORT-LAND BASIN, OREGON AND WASHINGTON, Geological Survey, Portland, OR. Water Re-

For primary bibliographic entry see Field 7C. W91-09500

DIGITIZED GEOPHYSICAL LOGS FOR SE-LECTED WELLS ON OR NEAR THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09502

SURFACE-CHEMICAL FACTORS AFFECTING TRANSPORT OF BIOCOLLOIDS IN SUBSUR-FACE POROUS MEDIA.

Arizona Univ., Tucson. Dept. of Hydrology and Water Resources. For primary bibliographic entry see Field 2K. W91-09505

WATER RESOURCES FOR ALASKA, WATER YEAR 1989.

Geological Survey, Anchorage, AK. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09507

WATER RESOURCES FOR COLORADO, WATER YEAR 1988, VOLUME 2, COLORADO RIVER BASIN.

Geological Survey, Lakewood, CO. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09508

WATER RESOURCES DATA FLORIDA, WATER YEAR 1989, VOLUME 4. NORTHWEST FLORIDA. Geological Survey, Tallahassee, FL. Water Re-

For primary bibliographic entry see Field 7C. W91-09509

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources For primary bibliographic entry see Field 7C. W91-09510

WATER RESOURCES DATA FOR MISSISSIP-PI, WATER YEAR 1989. Geological Survey, Jackson, MS. Water Resources

For primary bibliographic entry see Field 7C. W91-09511

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1983. Geological Survey, San Juan, PR. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09512

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1984. Geological Survey, San Juan, PR. Water Re-

sources Div. For primary bibliographic entry see Field 7C. W91-09513

WATER RESOURCES DATA SOUTH CAROLI-NA, WATER YEAR 1988.

Geological Survey, Columbia, SC. Water Re-For primary bibliographic entry see Field 7C. W91-09514

WATER RESOURCES DATA FOR WASHING-TON, WATER YEAR 1985.

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09515

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1989, VOLUME 3. WESTERN NEW YORK

Geological Survey, Ithaca, NY. Water Resources For primary bibliographic entry see Field 7C. W91-09516

WATER RESOURCES DATA FOR WISCON-SIN, WATER YEAR 1985

Geological Survey, Madison, WI. Water Re-For primary bibliographic entry see Field 7C. W91-09517 sources Div.

HYDROGEOLOGY AND GROUND-WATER RESOURCES OF SOMERSET COUNTY, MARYLAND.

Geological Survey, Dover, DE. Water Resources Div.

W. H. Werkheiser.

Available from Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218. Maryland Geological Survey, Baltimore, Bulletin 35, 1990. 156p, 42 fig, 9 pl, 14 tab, 53 ref, append.

Descriptors: \*Geohydrology, \*Groundwater level, \*Hydrogeologic units, \*Maryland, \*Water quality, \*Water resources data, Aquifer characteristics, Atlantic Coastal Plain, Choptank aquifer, Groundwater availability, Groundwater movement, Groundwater pollution, Manokin aquifer, Paleo-cene aquifers, Piney Point aquifer, Pocomoke aqui-fer, Potomac group.

Development in Somerset County Maryland is ex-Development in Somerset County Maryland is ex-pected to substantially increase the demand for groundwater. An assessment of the ground-water resource was conducted to gather baseline data against which future changes can be measured. The principal aquifers and aquifer systems are, in descending order, the surficial aquifer system, the Pocomoke aquifer, the Manokin aquifer, the Paleo-cene aquifer system, and the Potomac aquifer system. The surficial aquifer system is used primar-ily for domestic water supply. Dissolved iron and elevated nitrate concentrations are the most elevated nitrate concentrations are the most common water-quality problems. Specific capacity of the Pocomoke aquifer ranges from 2.0 to 17.3 gal/min/ft of drawdown. The most common water-quality problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems are excessive iron and manual transfer of the problems. ganese concentrations. The primary aquifer in the county is the Manokin aquifer. Hydraulic conductivity averages 13.2 ft/d. Water-level altitudes in the aquifer are below sea level, which could cause the aquiter are elector sea ievel, which could clause poor-quality water to migrate toward pumping centers. In the southern part of the county, chloride concentrations in the aquifer exceed the U.S. Environmental Protection Agency secondary maximum contaminant level (SMCL), and, in the northeastern part, iron concentrations exceed the SMCL. Transmissivity in the Paleocene and Poto-SMCL. transmissivity in the rateocene and Polo-mac aquifer systems averages 1,490 sq ft. Seven of ten water-quality samples from the aquifer systems contain fluoride concentrations above the SMCL. Under projected pumping conditions, simulated water levels in the Manokin aquifer near Princess Anne range from 15 to 70 ft below those measured in November 1086 Higher arrange of possible transin November 1986. Using a range of possible trans-

## **Group 2F—Groundwater**

missivities and projected pumpage increases, simulated water levels in the Crisfield area range from 7 to 31 ft below present levels. (USGS) W91-09522

GEOLOGY AND HYDROLOGIC ASSESSMENT OF COASTAL PLAIN AQUIFERS IN THE WALDORF AREA, CHARLES COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore.

Maryland Geological Survey, Battimore. W. B. Fleck, and J. M. Wilson. Available from Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218. Maryland Geological Survey Report of Investigations 53, 1990. 138p, 61 fig, 8 pl, 12 tab, 70 ref, append.

Descriptors: \*Coastal aquifers, \*Coastal plains, \*Geohydrology, \*Groundwater movement, \*Maryland, \*Model studies, Groundwater resources, Stratigraphy, Water resources.

From the stratigraphically highest aquifer to the lowest, the hydrogeologic section at Waldorf, lowest, the hydrogeologic section at Waldorf, Charles County, Maryland, consists of the surficial aquifer, the Aquia aquifer, the Waldorf aquifer system, the White Plains aquifer, the La Plata aquifer system, and the Patuxent aquifer system. The Waldorf aquifer system consists of three aquifers--the Monmouth, Magothy, and St. Charles--that are hydraulically connected by leaky confining units. The Waldorf and La Plata aquifer systems contain the most productive amifers in the systems contain the most productive amifers in the contining units. The Waldorf and La Plata aguiter systems contain the most productive aquifers in the Waldorf area. A ground water flow model was constructed to simulate the flow system of the aquifers in the Waldorf area and to assess their future water-supply potential. The model consisted of a rectangular grid of 38 rows, 29 columns, and 7 layers. Transient calibration was accomplished for the period 1000.45 to comparing model baseds with the period 1900-85 by comparing model heads with observed heads at about 130 observation wells. The model was used to estimate heads under seven pumpage scenarios for the period 1986-2020. Results of these scenarios indicated that about 6.6, 6.1, and 15.0 million/gal of groundwater/day is available from the Waldorf aquifer system, White Plains aquifer, and La Plata aquifer system, respectively. These totals are based on the assumption that the practical limit of drawdown is 80% of total available drawdown. Stratigraphic correlations through the Waldorf area show that the northeast-striking Brandywine fault system trends through the Waldorf area. Reduction of transmissivities in a narrow column of model cells that coincide with the trace of a major fault by 50% to 90% of the transmissi-vity values in adjacent model cells improved the calibration of the flow model. (USGS) W91-09523

SIMULATION OF THE EFFECTS OF GROUND-WATER WITHDRAWAL FROM A WELL FIELD ADJACENT TO THE RIO GRANDE, SANTA FE COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div. For primary bibliographic entry see Field 6G. W91-09525

RESULTS OF TEST DRILLING IN HOWELL TOWNSHIP, MONMOUTH COUNTY, NEW

Geological Survey, Trenton, NJ. Water Resources

G. A. Brown, and O. S. Zapecza. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4062, Jan 1991. 42p, 10 fig, 6 tab, 21 ref.

Descriptors: \*Coastal aquifers, \*Geohydrology, \*New Jersey, \*Observation wells, \*Water quality, Clay minerals, Drilling, Groundwater, Hydrogeologic units, Lithologic logs, Monmouth County, Permeability coefficient, Porosity, Well hydrographs, Well logs.

Test drilling was conducted during 1987-88 by the U.S. Geological Survey to define hydrogeologic conditions and water chemistry in southcentral Monmouth County, New Jersey. The drilling pen-

etrated 1,500 ft of Coastal Plain sediments consistetrated 1,500 ft of Coastal Piain sediments consist-ing of clay, silt, sand, and gravel of Quaternary, Tertiary and Cretaceous age, and 162 ft of weath-ered bedrock. A hard quartz-biotite-feldspar gneiss or schist was encountered at a depth of 1,662 ft. One observation well was installed in each of the five principal Coastal Plain aquifers to monitor long-term water-level fluctuations and to sample water quality. Wells were screened in the Vincenaquifer, the Wenonah-Mount Laurel aquifer, the Englishtown aquifer system, and upper aquifer of the Potomac-Raritan-Magothy aquifer system, and the deeper undifferentiated part of the Potomac-Raritan-Magothy aquifer system. In 1988, the highest water levels measured at the site were in the Vincentown aquifer and were about 43 to 56 ft below land surface. The lowest water levels were in the Englishtown aquifer system and were about 156 to 165 ft below land surface. Calcium and bicarbonate were the dominant ions in the water from all five aquifers. Specific conductance ranged from 106 uS/cm (microsiements/cm at 25 C) in the deepest aquifer to 241 uS/cm in the shallowest aquifer. Laboratory tests of hydraulic properties of 13 core samples from confining units indicated that porosities ranged from 37.9 to 50.4% and that vertical hydraulic conductivities ranged from 0.0000051 to 0.019 ft/day. (USGS)

FINITE-ELEMENT MODEL FOR SIMULA-TION OF TWO-DIMENSIONAL STEADY-STATE GROUND-WATER FLOW IN CON-FINED AOUIFERS.

Geological Survey, Austin, TX. Water Resources

Div. C. L. Kuniansky.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-187, 1990. 77p, 8 fig, 18 ref.

Descriptors: \*Finite element models, \*Groundwater models, \*Groundwater movement, \*Model studies, \*Regional Aquifer System Analysis.

A computer program based on the Galerkin finite-element method was developed to simulate two-dimensional steady-state groundwater flow in either isotropic or anisotropic confined aquifers. The program may also be used for unconfined aquifers of constant saturated thickness. Constant head, constant flux, and head-dependent flux nead, constant thus, and nead-dependent thus boundary conditions can be specified in order to approximate a variety of natural conditions, such as river or lake boundary, and pumping well. The computer program was developed for the preliminary simulation of groundwater flow in the Edwards-Trinity Regional aquifer system as part of the Regional Aquifer-Systems Analysis Program. Results of the programs compare well to analytical Results of the program compare well to analytical solutions and simulations from published finitedifference models. A concise discussion of the Ga-lerkin method is presented along with a description of the program. Provided in the Supplemental Data section are a listing of the computer program, definitions of selected program variables, and several examples of data input and output used in verifying the accuracy of the program. (USGS) W91-09532

GEOHYDROLOGY, GROUND-WATER QUALITY, AND SIMULATED GROUND-WATER FLOW, GEAUGA COUNTY, OHIO. Geological Survey, Columbus, OH. Water Re-

sources Div.

sources Div.

S. M. Eberts, E. S. Blair, and J. T. de Roche.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Water-Resources Investigations Report 90-4026, 1990. 117p, 39 fig, 48 ref.

Descriptors: \*Geauga County, \*Groundwater movement, \*Model studies, \*Ohio, \*Water quality, Brines, Deicers, Mathematical models, chemistry, Water pollution sources.

Data collected in 1978, 1980, 1985, and 1986 were used to assess spatial and temporal variations in groundwater quality, determine regional groundwater flow patterns, and predict regional changes in groundwater levels that might result from fore-

casted increases in groundwater development. casted increases in groundwater development. Variations in groundwater quality and groundwater flow patterns in Geauga County were characterized on the basis of water quality samples and water level measurements from wells completed in the glacial deposits, Pottsville Formation, Cuyation of the country of water level measurements from wells completed in the glacial deposits, Pottsville Formation, Cuya-hoga Group, Berea Sandstone, and two oil-produc-ing and gas-producing horizons. No significant changes in major and minor ion concentration were detected in the groundwater from 1978-86, except at isolated locations where water from several wells had elevated concentrations of sodium, calcium, bromide, and (or) chloride due to contamination by road salts and (or) oilfield and gas-field brine. A three-dimensional, steady-state flow model was used to simulate groundwater level declines that would result from increased domestic pumpage in the surficial aquifers. The estimates of groundwater level declines are based on forecasted population increases of 12, 17, and 21% during the population increases of 12, 17, and 21% during the periods 1985-95, 1985-2000, and 1985-2005, respectively. The simulations indicate the only areas of notable groundwater level decline would be in Chester Township, South Russell Village, the southern part of Russel Township, and Bainbridge Township. A maximum of 8 ft of decline is estimated. (USGS) W91-09534

MINERALOGICAL CORRELATION OF SUR-FICIAL SEDIMENT FROM AREA DRAINAGES WITH SELECTED SEDIMENTARY IN-TERBEDS AT THE IDAHO NATIONAL ENGI-NEERING LABORATORY, IDAHO. Geological Survey, Idaho Falls, ID. Water Re-

sources Div.

For primary bibliographic entry see Field 2J. W91-09536

GOVERNING EQUATIONS AND MODEL AP-PROXIMATION ERRORS ASSOCIATED WITH THE EFFECTS OF FLUID-STORAGE TRAN-SIENTS ON SOLUTE TRANSPORT IN AQUIFERS

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 5B. W91-09537

BASE OF MODERATELY SALINE GROUND WATER IN SAN JUAN COUNTY, UTAH. Geological Survey, Salt Lake City, UT. Water Resources Div.

L. Howells. Available from Utah Dept. of Natural Resources, 1636 W. North Temple, Salt Lake City, Utah 84116. Utah Dept. of Natural Resources Tech. Pub. 94, 1990. 35p, 8 fig, 1 tab, 39 ref.

Descriptors: \*Saline water, \*Saline-freshwater interfaces, Groundwater quality, Oil fields, Salinity, Water chemistry, Water quality.

The base of moderately saline groundwater (water that contains from 3,000 to 10,000 mg/L of dissolved solids) was delineated for San Juan County, Utah, based on water-quality data and formation-water resistivity determined from geophysical well logs using the resistivity-porosity, spontaneous-po-tential, and resistivity-ratio methods. These data and the contour map developed from them show that a thick layer of very saline to briny ground water (water that contains more than 10,000 mg/L of dissolved solids) underlies the eastern two-thirds of dissolved solids) underlies the eastern two-thirds of San Juan County. The upper surface of this layer is affected by the geologic structure of the area, but it may be modified locally by recharge mounds of less saline water and by vertical leakage of water through transmissive faults and fractures. The highest altitude of the base of moderately saline water is west of the Abajo Mountains where it is more than 6,500 ft above sea level. The lowest altitude is in the western part of the county and is below sea level; depressions in the base of moderately saline selvel; depressions in the base of moderately saline selvel. below sea level; depressions in the base of moder-ately saline water in recharge areas in the La Sal and Abajo Mountains also may be that low. The base of moderately saline water commonly is in the Permian Cutler Formation or the Pennsylvanian Honaker Trail Formation of the Hermosa Group, but locally may be as high stratigraphically as the Triassic and Jurassic Navajo Sandstone north of the Abajo Mountains and in the Jurassic Morrison Formation south of the mountains. (USGS)

HYDROLOGIC CONDITIONS AT ANAKTU-VUK PASS, ALASKA, 1989. Geological Survey, Anchorage, AK. Water Re-

Geological Survey, Alicholage, AR. Walet Resources Div. H. R. Seitz. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-591, 1991. 13p, 6 fig, 4 tab, 6

Descriptors: \*Alaska, \*Groundwater resources, \*Water supply, Brooks Range, Surface water, Water quality.

A review of hydrologic conditions at the village of A review of hydrologic conditions at the village of Anaktuvuk Pass, in the central Brooks Range of Alaska, was made in September 1989. The work was done to provide data that would assist the village in the location and development of additional water supplies needed to support a piped sewage-handling system. Well logs and water-quality data from existing wells indicated that the aquifer in the area north of the central supply well and adjacent to the west bank of Contact Creek would sustain a well canable of producing the would sustain a well capable of producing the needed volume of good-quality water. (USGS) W91-09541

SHALLOW GROUND WATER IN THE WHIT-NEY AREA, SOUTHEASTERN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA-PART I. DESCRIPTION OF CHEMICAL QUALITY,

Geological Survey, Carson City, NV. Water Re-

Geological survey,
Sources Div.
D. H. Emme, and D. E. Prudic.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Water-Resources Investigations Report 89-4117,
1991. 47p, 13 fig, 10 tab, 19 ref.

Descriptors: \*Geochemistry, \*Groundwater qual-ity, \*Las Vegas Wash, \*Nevada, \*Nonpoint pollu-tion sources, \*Saline water, \*Water pollution sources, Clark County, Dissolved solids, Ground-water, Groundwater sampling, Las Vegas, Ni-trates, Salinity control.

A prototype groundwater detention basin was proposed by the U.S. Bureau of Reclamation to A prototype groundwater detention usin was pur-posed by the U.S. Bureau of Reclamation to reduce the quantity of dissolved solids entering Las Vegas Wash, Nevada from groundwater seep-age, as part of an overall plan to reduce salinity in the lower Colorado River. This report describes groundwater quality in the area of the proposed basin and processes that may control the chemical quality. The 1-sq mi study area is adjacent to the uses, birst downstream from two wastewater treatquanty. The 1-sq mt study area is adjacent to the wash just downstream from two wastewater treatment facilities. The sediments beneath the proposed detention basin are primarily flood-plain deposits dominated by silt near land surface, silty sand between depths of 10 and 25 ft, and silt and clay below about 25 ft. Groundwater flow generally parallels the course of Las Vegas Wash. The water table at the proposed basin site is generally 1 to 4 ft below land surface, and it fluctuates seasonally in response to the changing rates of evapotran-spiration. Water samples were collected during a 16 month period from about 65 wells ranging in depth from 5 to 45 ft. Measured dissolved-solids depth from 5 to 45 ft. Measured dissolved-solids concentrations in the shallow groundwater range from about 2,000 mg/L, in an area affected by seepage of treated effluent and urban and storm runoff, to about 28,000 mg/L along the western edge of the study area. Geochemical interpretation of the water-quality data suggests that the amount and distribution of major ions in the groundwater is controlled by: seepage of treated effluent and urban runoff; dissolution of minerals by groundwater; and evapotranspiration, which tends to concentrate solutes near the water table. (USGS)

WATER RESOURCES OF HUTCHINSON AND TURNER COUNTIES, SOUTH DAKOTA,

Geological Survey, Huron, SD. Water Resources

R. J. Lindgren, and D. S. Hans Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4093, 1990. 100p, 41 fig, 9 tab, 38 ref.

Descriptors: \*Aquifers, \*Groundwater, \*Ground-water resources, \*South Dakota, \*Water resources data, Aquifer characteristics, Recharge, Surface water, Underground storage, Water quality.

Groundwater may be obtained from 11 glacial and 3 bedrock aquifers in Hutchinson and Turner Counties in southeastern South Dakota. The gla-Countes in southeastern South Dakota. The gla-cial aquifers are composed primarily of unconsoli-dated sand and gravel and contain about 5.2 mil-lion acre-ft of water in storage. Estimated maxi-mum well yields range from 50 to 1,000 gal/min. The predominant chemical constituents in water from the glacial aquifers are calcium, sodium, and sulfate. Average dissolved-solids concentrations in sulfate. Average dissolved-solids concentrations in water from the glacial aquifers ranged from 870 to 2,200 mg/L and average hardness concentrations ranged from 280 to 1,400 mg/L. Three bedrock aquifers, the Niobrara, Codell, and Dakota aquifers, contain about 18 million acre-ft of water in storage. Estimated maximum well yields are 1,000 gal/min for the Niobrara, 100 gal/min for the Codell, and 250 gal/min for the Dakota and quartzite wash aquifers. The predominant chemical constituents in water from the Niobrara and Dakota and quartzite wash aquifers are calcium, sodium, and sulfate. The predominant chemical constituents in water from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are sodium and sulfate. Average dissolved-solids consolium storage from the Codell aquifer are solid storage from sodium and sulfate. Average dissolved-solids con-centrations in water from the bedrock aquifers ranged from 1,450 to 1,510 mg/L and average hardness concentrations ranged from 230 to 670 mg/L. (USGS) W91-09543

SELECTED FACTORS RELATED TO THE PO-TENTIAL FOR CONTAMINATION OF THE PRINCIPAL AQUIFER, SALT LAKE VALLEY,

Geological Survey, Salt Lake City, UT. Water Resources Div. R. L. Baskin.

R. L. Baskin. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4110, 1990. 35p., 12 fig., 18 ref.

Descriptors: \*Groundwater resources, \*Water pol-

lution sources, Contamination, Groundwater movement, Groundwater recharge, Natural re-charge, Water pollution, Water quality.

Selected factors related to potential movement of contaminants to and within the principal aquifer at Salt Lake City, Utah include recharge area and sources of recharge, direction of groundwater flow, and transmissivity. Factors related to potential effects and origin of contaminants include location of highest quality water in the principal aquifer, location of areas of poor quality water in the overlying shallow unconfined aquifer, effects of increased groundwater withdrawals on vertical flow, and locations of public-supply wells and springs, urbanized areas, and hazardous-waste sites. The primary recharge area for the principal aquifer The primary recharge area for the principal aquifer in Salt Lake Valley is along the western edge of the Wasatch Range and the eastern edge of the Oquirrh Mountains. In this area, the principal aquifer is unconfined and is susceptible to movement of contaminants from the land surface to the water contaminants from the land surface to the water table. The primary sources of recharge to the principal aquifer are inflow of water from fractured consolidated rock and seepage from streams emerging from the mountains. Areas where the water in the principal aquifer is of high quality and is used for public supply are areas where contamination would have especially serious consequences. Urbanized areas and locations of hazardous-waste sites are sources of potential contaminants. Where these locations coincide, are in recharge areas, or are near public-supply wells, the principal aquifer is susceptible to contamination and the contamination of the principal aquifer can affect public water supplies. (USGS)

W91-09544

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1990, VOLUME 1B: NORTH-EAST FLORIDA - GROUND WATER. Geological Survey, Altamonte Springs, FL. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09545

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources

For primary bibliographic entry see Field 7C. W91-09546

WATER RESOURCES DATA FOR TENNES-

Geological Survey, Nashville, TN. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09547

GROUND-WATER-FLOW SYSTEMS IN THE POWDER RIVER STRUCTURAL BASIN, WYOMING AND MONTANA.

Geological Survey, Cheyenne, WY. Water Resources Div. For primary bibliographic entry see Field 2E. W91-09548

EFFECTS OF STORM-WATER RUNOFF ON LOCAL GROUND-WATER CLARKSVILLE, TENNESSEE. QUALITY. Geological Survey, Nashville, TN. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-09550

INFILTRATION AND EVAPOTRANSPIRA-TION WITHIN THE ALBUQUERQUE, NEW MEXICO, AREA WITH A SECTION ON HIS-TORICAL WATER-RESOURCE TRENDS DURING THE 1954-80'S PERIOD OF URBAN GROWTH.

Geological Survey, Albuquerque, NM. Water Resources Div.

For primary bibliographic entry see Field 2D. W91-09551

STREAMFLOW LOSSES AND GROUND-WATER LEVEL CHANGES ALONG THE BIG LOST RIVER AT THE IDAHO NATIONAL EN-GINEERING LABORATORY, IDAHO. Geological Survey, Idaho Falls, ID. Water Re-

sources Div. C. M. Bennett.

C. M. Bennett.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4067, 1990. 49p, 18 fig. 11 tab, 9 ref. Contract No. DE-AI07-81ID12306. Project No. ID-165.

Descriptors: \*Groundwater recharge, \*Idaho National Engineering Laboratory, \*Influent streams, \*Surface-groundwater relations, Groundwater movement, Infiltration, Streamflow.

The Big Lost flows onto the eastern Snake River Plain near Arco, Idaho, and across the INEL (Idaho National Engineering Laboratory). Streamflow recharges the Snake River Plain aquifer from the Big Lost River channel, the INEL spreading areas, and playas at the river terminus. Average annual streamflow for the Big Lost Plaine from areas, and palyas at the three terminus. Average annual streamflow for the Big Lost River from 1965 to 1987 above the INEL diversion was 104,436 acre-ft; about 50% of this flow was diverted to the INEL spreading areas, about 9% infiltrated between the INEL diversion and Lincoln Boulevard, and the remainder infiltrated below Lindows 104, 200 and 1964 an coln Boulevard or flowed into playas. Streamflow losses to evapotranspiration were minor compared to infiltration losses. Infiltration loss was estimated

## Group 2F-Groundwater

along the 44 river miles from Arco to playa 1 at discharges ranging from 37 to 372 cu ft/sec. At discharges less than 100 cu ft/sec, loss from Arco to the Big Lost River Sinks was 1 to 4 cu ft/sec/mile. Loss from the sinks to playa 1 ranged from 7 to 12 cu ft/sec/mile. Infiltration loss was greatest at large discharges. At a discharge of 372 cu ft/sec, a loss of 28 cu ft/sec/mi was estimated in the area of the Big Lost River Sinks. Recharge from the Big Lost River is substantial immediately south-west of the Radioactive Waste Management Complex and in the area from the Naval Reactor Facili-ty to playas 1 and 2. (USGS) W91-09552

WATER-RESOURCES POTENTIAL OF THE FRESHWATER LENS AT KEY WEST, FLORI-

Geological Survey, Miami, FL. Water Resources Div. For primary bibliographic entry see Field 5B. W91-09554

GEOGRAPHIC INFORMATION SYSTEM DATA BASE FOR COAL AND WATER RESOURCES OF THE POWDER RIVER COAL REGION, SOUTHEASTERN MONTANA.
Geological Survey, Helena, MT. Water Resources Div.

Div.

For primary bibliographic entry see Field 7C. W91-09557

WATER-RESOURCES INVESTIGATIONS IN TENNESSEE: PROGRAMS AND ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY, 1990-91. Geological Survey, Nashville, TN. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09558

NONEQUILIBRIUM ADSORPTION DURING REACTIVE CONTAMINANT TRANSPORT THROUGH HETEROGENEOUS AQUIFERS. Illinois Univ., Urbana. Dept. of Civil Engineering.

A. J. Valocchi. Available from National Technical Information Available from National Technical Information Service, Springfield, VA 22161 as PB91-136200/ AS. Price codes: A03 in paper copy, A13 in micro-fiche. Final Technical Report, September 1989, 43p, 16 fig, 2 tab, 47 ref. USGS Contract No. 14-08-0001-G1299.

Descriptors: \*Adsorption, \*Flow models, \*Groundwater pollution, \*Model studies, \*Path of pollutants, \*Solute transport, Adsorption kinetics, Aquifers, Groundwater movement, Mathematical models, Stochastic process, Water pollution

This project addressed the case where groundwatrins project audiessed the case where groundwar-er pollutant transport is affected by hydraulic con-ductivity field heterogeneity and by nonequili-brium adsorption reactions. The research method-ology consisted of development and application of numerical transport models. Adsorption was assumed to be governed by a first-order reversible rate expression with spatially uniform reaction parate expression with spatianty uniform fraction parameters; hydraulic conductivity was assumed to be a realization of a lognormally distributed random field having isotropic exponential spatial covariance. Novel finite-difference groundwater flow and random-walk solute transport models that are highly efficient on supercomputer architectures were developed. These models were utilized to conduct a suite of numerical experiments for vary-ing degrees of heterogeneity and for different reac-tion rates. The results indicated that the overall longitudinal spatial variance of the aqueous-phase solute plume could be expressed as the sum of the variance due to conductivity heterogeneity plus that due to adsorption kinetics. The latter effect can be approximately quantified by earlier results for perfectly stratified aquifers. An approximate simplified formula is presented to quantify the impact of kinetics relative to that of heterogeneity. The results show that deviations from local equilibrium behavior diminish as the variance of the ln K field increases. (USGS)

APPLICATIONS OF DOWN-WELL/DOWN-WELL AND DOWN-WELL/SURFACE RESISTIVITY TECHNIQUES TO EVALUATE GROUND WATER FLOW IN FRACTURES. Connecticut Univ., Storrs. Dept. of Geology and

Geophysics.

J. M. Martin-Hayden, and G. A. Robbins.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-136291/

AS. Price codes: A08 in paper copy, A08 in microfiche. Connecticut Institute of Water Resources, Storrs, Final Report, October 1990. 143p, 35 fig. 28 tab, 23 ref, 2 append. USGS Contract No. 14-08-0001-G1412. USGS Project No. G1412-05.

Descriptors: \*Conductivity, \*Electrical studies, \*Geologic fractures, \*Model studies, \*Resistivity, \*Testing procedures, Analytical techniques, Borehole geophysics, Geophysics, Groundwater, Well

Many techniques exist for examining bedrock hy-drology including surficial and bore-hole methods. Cross-well conductivity may be used to enhance other methods and to provide additional informa-tion for characterization of bedrock hydrology. The cross-well conductivity technique involves ap-plying a low frequency alternating current to elec-trodes suspended within two bedrock wells and trodes suspended within two bedrock wells and measuring resulting voltage between electrodes or between one of the electrodes and other wells. Hydrological data may be used in conjunction with electrical data to provide further information on bedrock properties. Laboratory and field studies tested practical application of the theory. In the laboratory, fracture model apertures measured with the cross-well conductivity technique reasonably matched those measured hydrologically. The technique was also found to be sensitive to apertechnique was also found to be sensitive to aper-ture expansion and spatial aperture variations. In the field, determination of total fracture space of bedrock compared well with slug test information and core observations. Using electrical data in conjunction with the slug test suggested that a large number (thousands) of thin (0.01 mm) frac-tures cut the 3 meters of bedrock. The measured that the suggested that a suggested that a size of the suggested that a suggested that suggested th electrical heterogeneity corresponded well with the core observations and slug test results. The technique was also used to measure bulk bedrock conductivity, and values obtained correlated well with those measured using a surficial electrical conductivity technique. The technique was found to provide information on fracture aperture width and hydraulic conductivity, fracture density, heterogeneity, anisotrophy, and hydraulic connectiveness of well pairs. The cross-well conductivity technique provides a direct measurement of bedictives of the content of t rock properties and is representative of the entire area between the wells. In addition the technique may be implemented with inexpensive, readily available equipment, and is simple to execute. (USGS) W91-09569

QUALITY ASSURANCE IN THE APPLICA-TION OF GROUNDWATER MODELS.
Butler Univ., Indianapolis, IN. Holcomb Research

For primary bibliographic entry see Field 7C. W91-09580

CASE STUDY FOR THREE-DIMENSIONAL NUMERICAL GROUNDWATER FLOW MOD-

ELING,
Weston (Roy F.), Inc., West Chester, PA.
A. Acharya, J. Y. Yang, J. E. Brinkman, G. T.
Yeh, and R. J. Young.
In: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 111-120. 5 fig, 1 ref.

Descriptors: \*Computer models, \*Data interpreta-tion, \*Finite element method, \*Groundwater movement, \*Groundwater pollution, \*Hydrologic models, \*Model studies, \*Water pollution treat-ment, Confined aquifers, Flow models, Geohydro-log, Hydrolis properties of the property of the prology, Hydraulic conductivity, Industrial wastes, Mathematical models, Site remediation, Unconfined aquifers, Waste disposal.

A three-dimensional flow model using 3DFEM-WATER, a finite-element code, was developed to

assess contamination beneath a former industrial waste lagoon (IWL) at Tooele, Utah. The geology consists of sandstone/quartzite and fractured limestone bedrock as an isolated block in a thick sequence of unconsolidated sediments consisting of quence of unconsolidated sediments consisting of interlayered and unconsolidated sand, gravel, silt and clay. The conceptual model is composed of six layers of elements (750 feet thick and 7 layers of nodes), eight alluvial materials types and three bedrock material types. The modeled area is 24,000 feet by 12,000 feet. The finite-element mesh, having 21 nodes per row, 11 nodes per column, contains a total of 1,617 nodes and 1,200 three-dimensional elements. The six layers of elements represent the aquifer system which is heterogeneous and consists of both alluvial and fractured bedrock components under unconfined and consists of both alluvial and fractured ous and consists of both aluvial and tractured bedrock components under unconfined and confined conditions. After undergoing a sensitivity analysis, the model was calibrated using distributed hydraulic conductivity over the eleven material types to match measured versus calculated heads. The calibrated flow model is a useful tool for designing groundwater restoration alternatives, in-cluding number of extraction and injection wells, well locations, well depths, well pumping and injection rates, and duration of pumping and injection. (See also W91-09570) (Author's abstract)

POTENTIAL PITFALLS IN USING GROUND-WATER MODELS.

Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-09583

TRANSFERRING MODEL-OPERATING RESPONSIBILITY FROM A FEDERAL TO A STATE AGENCY.

North Carolina Dept. of Environment, Health, and Natural Resources, Raleigh. For primary bibliographic entry see Field 7C. W91-09584

CRITICAL ERRORS THAT HYDROGEOLO-GIC PROFESSIONALS CAN MAKE WITH COMPUTER PROGRAMS.

Butler Univ., Indianapolis, IN. Holcomb Research For primary bibliographic entry see Field 7C.

EXPERIENCES IN USING MODELOW ON A

PC.
K.N. Toossi Univ. of Technology, Tehran (Iran).
For primary bibliographic entry see Field 7C.

MODEL SPATIAL VARIATION AND CORRE-LATION OF HYDRAULIC CONDUCTIVITY IN NATURAL MEDIA.

Delta Environmental Consultants, Inc., Tampa,

For primary bibliographic entry see Field 7C.

GROUND WATER ISSUES AND SOLUTIONS IN THE POTOMAC RIVER BASIN/CHESA-PEAKE BAY REGION.

Proceedings of a symposium held at George Washington University, Washington, DC, March 14-16, 1989. National Water Well Association, Dublin, Ohio. 1989, 525p.

Descriptors: \*Chesapeake Bay, \*Groundwater, \*Groundwater pollution, \*Nonpoint pollution sources, \*Potomac River Basin, \*Water pollution prevention, Agricultural practices, Aquifer characteristics, Estuaries, Groundwater management, Saline water intrusion, Water quality control.

The states of Maryland and Pennsylvania, along with the Commonwealth of Virginia and the District of Columbia, have made great strides in protecting water quality in the Chesapeake Bay and its tributaries. Their renewed efforts to protect water

## Groundwater-Group 2F

quality in the Chesapeake Bay area have resulted in a number of useful programs. In addition, public awareness has been raised regarding the protection of water resources. The Association of Groundwater Scientists and Engineers presented a confer-ence on Groundwater Issues and Solutions in the ence on Groundwater Issues and Solutions in the Potomasc River/Chesapeake Bay Region in March of 1989 to provide insight on groundwater-related issues. More than thirty papers were presented dealing with research projects and field studies. Topics included geohydrologic relationships, groundwater quality impacts, impact of industrial process on groundwater quality, salt water intrusion, groundwater protection in the Chesapeake Bay region, land use impacts on groundwater qual-Bay region, land use impacts on groundwater quality, groundwater modeling, groundwater withdrawals, and policy issues. The meeting was attended by people from both the public and private sector. (See W91-09629 thru W91-09656) (Author's abstract) W91-09628

GROUNDWATER IN THE NATION'S CAP-ITAL: BEYOND POTABILITY. District of Columbia Univ., Washington. Dept. of

Environmental Science.

J. V. O'Connor

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 1-8. 3 tab, 13 ref.

Descriptors: \*District of Columbia, \*Geochemistry, \*Groundwater, \*Groundwater availability, \*Groundwater pollution, \*Potable water, Case studies, Coastal aquifers, Coastal plains, Dewatering, Geologic fractures, Groundwater manage-

The District of Columbia lies along the fall zone of the Potomac River, which is the boundary between the Piedmont Plateau and the Atlantic Coastal Plain regions. While there is an abundance of groundwater under the nation's capital, the natural water quality on either side of the fall zone differs. In Coastal Plain units, the high iron and sulfur content impacts foundations and buried utility. ty lines. The numerous fracture systems in Pied-mont rocks and saprolites results in geochemical interaction between rock and water along the crack systems. Fractures or geologic boundaries exposed on hillsides create springs. Twenty-five exposed on hillsides create springs. Twenty-five case studies are listed which indicate the diversity of groundwater problems in the nation's capital. Successful groundwater investigations require an understanding of the regional geology, climatology, history, land use changes, contamination types, gy, history, land use changes, contamination types, and construction concerns. Laws are now in place to monitor and protect the city's subsurface water resources, but the monitoring process for both quality and quantity needs to be implemented quickly to establish legal baselines. The District is a recharge area for the confined Potomac aquifer which is a major water supply in Maryland. Construction dewatering wells account for the largest use of groundwater in the city. Groundwater withdrawals per site are about fifty thousand gallons per day. (See also W91-09628) (Author's abstract) W91-09629

CHESAPEAKE BAY'S HIDDEN TRIBUTARY: SUBMARINE GROUNDWATER DISCHARGE. Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology. G. M. Simmons.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989 p. 9.2 0 124 h 30 ref.

1989. p 9-29. 9 tab, 39 ref.

Descriptors: \*Advection, \*Chesapeake Bay, \*Groundwater movement, \*Surface-groundwater relations, \*Underflow, \*Virginia, Groundwater quality, Nonpoint pollution sources, Nutrient transport, Saline-freshwater interfaces, Salinity,

The movement of water across sediment/water interfaces due to advective flow does not appear to be a widely recognized or appreciated ecological property of many aquatic habitats. Advective flow

may be due to a variety of factors, but in inshore coastal environments the major factor is probably groundwater flow from upland regions. The move-ment of water across the sediment/water interface in aquatic habitats is commonly referred to as submarine groundwater discharge (SGWD), and is a mixture of fresh groundwater and seawater in coastal environments. The magnitude of the dis-charge and the role of SGWD in the transport of charge and the role of SGWD in the transport of dissolved compounds seems to be unrecognized. The phenomenon seems to be so pervasive that a lack of understanding and appreciation of SGWD has probably led to misinterpretations of many ecological problems. SGWD was investigated at four sites on Virginia's Eastern Shore, for both volume and the variation in water quality with respect to land use and sediment type. When the means of discharge rates are expanded for the means of discharge rates are expanded for the entire Bay margin, the first preliminary estimate of the discharge magnitude is that of a major tributary, on the order of the James River or the Rappahannock River. Given the similarity between SGWD and primary tributary discharge, the contribution of SGWD and its associated solutes should be incorporated into Chesapeake Bay non-point source management plans. (See also W91-09628) (Author's abstract) W91-09630

CHEMICAL INTERACTIONS BETWEEN SUR-FACE WATER AND GROUND WATER IN THE ZEKIAH SWAMP RUN STREAM VALLEY. Environmental Resources Management, Inc., An-

Environmental Resources management, and the napolis, MD.
R. M. Price, and R. W. Keating.
IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region.
National Water Well Association, Dublin, Ohio.
1989, p 31-45. 5 fig, 2 tab. 7 ref.

Descriptors: \*Base flow, \*Dissolved solids, \*Groundwater, \*Influent streams, \*Surface-groundwater relations, \*Water chemistry, Chemical analysis, Fly ash, Maryland, Stiff diagrams, Stream discharge, Tracers.

Zekiah Swamp Run, in Charles County, Maryland, drains an area of approximately 110 square miles into the Wicomico River, a tributary of the Potomac River. An electric utility fly ash fill is located towards the southern end of the north-south trending Zekiah Swamp Run Valley. Dissolved major ion constituents, derived from the fly ash fill, were used as tracers to investigate the chemical interac-tions between surface water and groundwater within the valley. Groundwater occurs under un-confined conditions in the Pleistocene Age sand and gravel aquifer. This aquifer is five to twenty feet thick and underlain by the confining silts of the Calvert Formation. Intermittent streams in the watershed are tributaries of Zekiah Swamp Run, and in places are hydraulically connected to the sand and gravel aquifer. Nine observation wells in the sand and gravel aquifer provided hydrologic and groundwater quality data. Groundwater sam-ples and twelve surface water samples were collected and analyzed for major cations and anions during three consecutive bimonthly sampling events. Stiff diagrams were constructed using major ion constituents to determine the chemical interaction between groundwater and surface water. These diagrams indicate that groundwater discharges to the upper reaches of the intermittent streams, thereby affecting the chemical character of the streams there. Further downgradient the reverse seems to be true; the intermittent streams recharge the aquifer system prior to discharge, affecting the water chemistry of the groundwater. (See also W91-09628) (Author's abstract) W91-09631

GEOPHYSICAL BOREHOLE LOGGING, AP-PLICATIONS (AND LIMITATIONS) TO GROUNDWATER INVESTIGATIONS IN SHALLOW AND SMALL DIAMETER WELLS. For primary bibliographic entry see Field 7B. W91-09632

EVALUATION OF PATAPSCO AQUIFER HYDRAULICS BY TIDAL FLUCTUATION RE-

O'Brien and Gere Engineers, Inc., Syracuse, NY. P. Bogardus, G. Swenson, and J. Mickam. IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 69-81. 9 fig, 2 tab, 4 ref.

Descriptors: \*Aquifer characteristics, \*Chesapeake Bay, \*Groundwater tides, \*Patapsco Aquifer, \*Tidal effects, Coastal aquifers, Confined aquifers, Leaky aquifers, Maryland, Monitoring wells, Tidal

A tidal monitoring study was conducted on the Patapsco Aquifer at a site adjacent to Curtis Bay, an estuary of the Chesapeake, in Baltimore, Maryland. The study evaluated the hydraulic connection of the Patapsco Aquifer with Curtis Bay. This was accomplished by continuously monitoring groundwater elevations in the Patapsco Aquifer and executing tidal fluctuations in Curtis Bay Groundwater elevations in the Patapsco Aquifer groundwater elevations in the ratapsec Aquirer and recording tidal fluctuations in Curtis Bay for a period of one week. Data were collected from wells at variable distances from the shoreline, and the relative change in diurnal hydrograph amplitude was evaluated together with the time lag between fluctuation maximums and minimums. between fluctuation maximums and minimums. These evaluations were then used to predict the location of the subaqueous outcrop. With these data, aquifer storage coefficients were calculated from equations developed by Ingersoll, Zobel and Ingersoll in 1948. In addition, the vertical hydraulic potential of groundwater was evaluated. The results of the study indicate that Patapsco Aquifer at this locale is in direct hydraulic connection with Curtis Bay. The distance to subaqueous outcrop was calculated to be between 600 and 1160 feet from the shore. Aquifer storage coefficients indi-cate leaky confined conditions. (See also W91-09628) (Author's abstract)

GROUNDWATER NON-POINT SOURCES OF NUTRIENTS TO THE SOUTHERN CHESA-PEAKE BAY.

Virginia Inst. of Marine Science, Gloucester Point. For primary bibliographic entry see Field 5B. W91-09634

NITROGEN TRANSPORT IN GROUND WATER IN TWO GEOLOGIC SETTINGS, PATUXENT RIVER BASIN, MARYLAND. Geological Survey, Towson, MD. Water Re-

sources Div. E. R. McFarland.

In: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 105-124. 6 fig. 13 ref.

Descriptors: \*Geohydrology, \*Groundwater, \*Groundwater chemistry, \*Groundwater recharge, \*Nitrogen, \*Nonpoint pollution sources, \*Nutrient transport, Coastal aquifers, Groundwater quality, Maryland, Precipitation, Saprolite, Vadose zone.

Nitrogen transport in groundwater is being investigated at two hydrogeologically diverse sites in the Patuxent River basin in Maryland. One site, in the Coastal Plain physiographic province, is underlain by a shell-bearing, fine sand aquifer. The other site, in the Piedmont physiographic province, is under-lain by a fractured bedrock/saprolite aquifer. The data are being collected over a 4-year period from 1986 to 1990 to determine changes in groundwater 1986 to 1990 to determine changes in groundwater flow and nitrogen transport resulting from a change in farming practice. Legumes were grown at both sites during 1987 and 1988, without irrigation. Preliminary findings indicate that nitrogen originating from the land surface is transported to the aquifers by recharge. Recharge duration, groundwater quality, and speciation of nitrogen differ between the two sites primarily because of the differences in geologic settings. At the Coastal Plain site recharge occurs rapidly from late fall brough winter. Nitrogen in groundwater increases in concentration during recharge as it is transported to the aquifer. Nitrogen is oxidized to form nitrate, which is transported through the aquifer to the Patuxent River. At the Piedmont site, precipi-

## Group 2F-Groundwater

tation percolates through a thick, silty unsaturated zone and is more gradual, lasting most of the winter and spring. Groundwater is increasingly anaerobic with depth because of pyrite weathering.

After the recharge season at both sites, water steadily discharges from aquifer storage and nitrogen in groundwater decreases in concentration as it is flushed from the aguifer by the learning as it ed from the aquifer by less concentrated, deeper water. Increased evapotranspiration impedes recharge and nitrogen transport until late fall/early winter when evapotranspiration decreases. (See also W91-09628) (Author's abstract)

CHARACTERIZATION OF POLLUTION PO-TENTIAL USING HYDROGEOLOGIC SET-TINGS FOR THE FRACTURED ROCKS NEAR THE POTOMAC RIVER, MONTGOMERY COUNTY, MARYLAND.

Geomatrix, Inc., Riverdale, MD. For primary bibliographic entry see Field 5B. W91-09636

EFFECT OF AGRICULTURAL CHEMICALS ON GROUNDWATER QUALITY, NORTHERN SHENANDOAH VALLEY, VIRGINIA. Virginia Univ., Charlottesville.

For primary bibliographic entry see Field 5B. W91-09637

HYDROCHEMICAL PROCESSES AFFECTING CONTAMINANTS NEAR THE GROUND-WATER/SURFACE-WATER INTERFACE, AB-WATER/SURFACE-WATER INTERFACE, AB-ERDEEN PROVING GROUND, MARYLAND. Geological Survey, Towson, MD. For primary bibliographic entry see Field 5B.

W91-09638

SIMULATION OF BRACKISH-WATER FLOW IN THE AQUIA AQUIFER, KENT ISLAND, MARYLAND.

Maryland Geological Survey, Baltimore. D. D. Drummond.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 187-210. 14 fig, 1 tab, 6 ref.

Descriptors: \*Brackish water, \*Coastal aquifers, \*Groundwater, \*Groundwater movement, \*Model studies, \*Saline water intrusion, \*Saline-freshwater interfaces, Computer models SUTRA model, Salinity currents. models,

Brackish water is present in the Aquia aquifer in the area adjacent to the Chesapeake Bay on Kent Island, Maryland. The Aquia aquifer is composed issand, Maryiand: The Aquia aquiter is composed of sediments of Paleocene and Eocene age; the sediments consist of fine to medium-grained glau-contitic sand, containing layers of clayey sand, layers indurated by calcite cement, and abundant shell material. On the northern part of the island the entire vertical section of the Aquia aquifer contains brackish water but the top contains fresh water. A two-layer areal flow model was developed to simulate the response of water levels to projected pumpage in the Aquia aquifer. This flow model was used to compute boundary and initial conditions for a cross-sectional solute transport model. The solute transport model was then used to estimate the flow of brackish water in response to projected pumpage, and to evaluate the impor-tance of hydrogeologic controls on the distribution and flow of brackish water. Model results indicate and flow of brackish water. Model results indicate that the freshwater/brackish-water interface will move about 440 feet inland during the 21-year simulation period, 1985-2005, based on the best estimate of future pumpage, at an average interface velocity of about 21 feet per year. Simulations designed to evaluate the importance of hydrogeo-legic controls on brackish water flow indicates by logic controls on brackish-water flow indicate that density-dependent flow, water pressures in the Aquia aquifer, and the type of upper confining bed are the most important controls. Calcite-cemented layers and paleochannel sediments provide minor controls on brackish-water flow in the Kent Island area. (See also W91-09628) (Author's abstract) SUMMARY OF BRACKISH-WATER INTRU-SION IN COASTAL PLAIN AQUIFERS, NORTHERN CHESAPEAKE BAY AREA, MARYLAND.

Geological Survey, Towson, MD. S. W. Phillips, and B. J. Ryan.

In: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p.211-235. 15 fig, 18 ref.

Descriptors: \*Brackish water, \*Chesapeake Bay, \*Coastal aquifers, \*Groundwater, \*Maryland, "Coastal aquifers, "Groundwater, "Maryland, "Saline water intrusion, "Saline-freshwater inter-faces, Aquifer characteristics, Coastal plains, Estu-arine sediments, Geohydrology, Unconsolidated

Water has become more mineralized as a result of intrusion of brackish water in the Coastal Plain intrusion of orackish water in the Coastal Plain aquifers underlying the northern Chesapeake Bay area in Maryland. The hydrogeology of the study area is a complex system of unconsolidated sands, silts, and clays. The major aquifers from oldest to youngest include the Patuxent and Patapsco aquifers in the Potomac Group near Baltimore, and the Macachy and Acing aquifers. The Augustal aquirers in the Fotomac Group near Battimore, and the Magothy and Aquia aquifers. The Arundel Formation is a confining unit that separates the Patuxent and Patapsco aquifers in the Baltimore area. Brackish water was reported in the Patuxent aquifer as early as the 1890s and, as late as 1981, aquifer as early as the 1890s and, as late as 1981, water in the aquifer contained chloride concentrations as high as 6,000 milligrams per liter (mg/l). Groundwater withdrawals of 3 to 4 million gallons per day from the Patapsco aquifer near Baltimore resulted in the intrusion of brackish water in the early 1900s and partial abandonment of the aquifer as a potable supply by 1945. Chloride concentrations as high as 1,700 mg/l have been measured in the Aquija aquifer per Annapolis and concentrathe Aquia aquifer near Annapolis, and concentra-tions as high as 7,400 mg/l have been measured near Kent Island. Factors contributing to brackish-water intrusion into the aquifers include, but may not be limited to (1) water levels in the aquifer relative to sea level, (2) the distribution of aquifer outcrop and subcrop areas and overlying confining units, (3) the nature of bottom sediments in Chesapeake Bay and its tributaries, and (4) the distribution of and sedimentary sequence in paleochannels. (See also W91-09628) (Author's abstract) W91-09640

REDUCTION OF NITRATE LOADINGS TO GROUNDWATER.

Maryland Univ., College Park. Dept. of Agricul-Tural Engineering.

For primary bibliographic entry see Field 5G.
W91-09642

COVER CROPS: A PARAGON FOR NITRO-GEN MANAGEMENT.

Maryland Univ., Queenstown. Wye Research and Education Center.

For primary bibliographic entry see Field 5G. W91-09643

EFFECT OF STORM-WATER IMPOUND-MENTS ON MAJOR-ION RATIOS IN GROUND WATER.

For primary bibliographic entry see Field 5B. W91-09644

MUNICIPAL AND INDUSTRIAL LANDFILL LEACHATE MOBILITY THROUGH THE WATER TABLE AQUIFER SYSTEM OF THE NORTHERN VIRGINIA COASTAL PLAIN

Resource International, Ltd., Ashland, VA For primary bibliographic entry see Field 5B.

LAWN AND GARDEN CHEMICALS AND THE POTENTIAL FOR GROUNDWATER CONTAMINATION.

New Hampshire Univ., Durham. For primary bibliographic entry see Field 5B. IMPACTS OF HIGHWAY DEICING PRO-GRAMS ON GROUNDWATER AND SURFACE WATER QUALITY IN MARYLAND.

GeoTrans, Inc., Herndon, VA. For primary bibliographic entry see Field 5B. W91-09648

FLOW PATH OF PESTICIDES IN THE DELA-WARE AND MARYLAND PORTION OF THE CHESAPEAKE BAY REGION.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 5B. W91-09649

QUANTITATIVE TECHNIQUES APPLICABLE TO PROTECTION OF WATER SUPPLY WELLS IN THE CHESAPEAKE BAY AREA. Geraghty and Miller, Inc., Reston, VA. Modeling

For primary bibliographic entry see Field 5G. W91-09654

SOLUTE BUDGET FOR AN ARID-ZONE GROUNDWATER SYSTEM, LAKE AMADEUS, CENTRAL AUSTRALIA.

Bureau of Mineral Resources, Geology and Geo-physics, Canberra (Australia). For primary bibliographic entry see Field 2K. W91-09688

HYDROGEOLOGY AND GROUNDWATER RE-SOURCES DEVELOPMENT OF THE CAMBRO-ORDOVICIAN SANDSTONE AQUI-FER IN SAUDI ARABIA AND JORDAN.

Birmingham Univ. (England). School of Earth Sci-

ences. J. W. Lloyd, and R. H. Pim. Journal of Hydrology JHYDA7, Vol. 121, p 1-20, December 1990. 11 fig, 6 tab, 20 ref.

Descriptors: \*Aquifer systems, \*Aquifers, \*Geohydrology, \*Groundwater mining, \*Groundwater potential, \*Groundwater resources, \*Jordan, \*Model studies, \*Saudi Arabia, Arid lands, Drinking water, Groundwater recharge, Irrigation, Sandstones, Soil types, Water management, Water supply.

The Sag Cambro-Ordovician sandstones form the major national aquifer in Saudi Arabia and Jordan. The investigation and groundwater development experience in the sandstones and resulting aquifer response data, are substantial and are reviewed as an example of major arid zone groundwater ab-straction and groundwater mining. Significant abstraction of groundwater has taken place since the early 1950s. Modeling of the aquifer responses to testing and abstraction shows that the sandstones have a moderately high transmissivity and a large specific yield. The groundwater quality is excellent for irrigation which is the present major use, and is also good for potable purposes. Although large drawdowns are being experienced locally in confined areas of the aquifer, unconfined area responses show the aquifer to have an excellent potential for development under groundwater mining principles that may be considered for use outside the areas of occurrence. As modern re-charge is minimal, the long-term management of abstraction from the aquifer will be dependent upon groundwater mining controlled by uncon-fined area dewatering, typical of an arid environ-ment. With abstraction steadily increasing from the aquifer, attention is now being drawn to more comprehensive management of the development of the resource on a local basis for irrigation, predominantly, but also on a wider national basis for possible potable use. (Agostine-PTT) W91-09708

DISSOLVED COMMON GASES IN GROUND-WATERS OF THE APPALACHIAN REGION. Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Science Teaching. E. Almon, and M. Magaritz.

## Groundwater-Group 2F

Journal of Hydrology JHYDA7, Vol. 121, p 21-32, December 1990. 7 fig, 1 tab, 16 ref.

Descriptors: \*Appalachian Mountains, \*Gases,
\*Geochemistry. \*Groundwater Geochemistry, Groundwater chemistry, Groundwater recharge, Water chemistry, Agration zone, Argon, Atmospheric gases, Dentirification, Nitrogen, Oxidation, Oxygen, Radioactive half-life, Saturation zone, Springs,

Groundwater contains various concentrations of orroundwater contains various concentrations of common atmospheric gases such as N2, O2 and Ar. The concentration of each gas found at a given site is related to one or more of the following mechanisms: (1) the equilibrium solubilities of the gases at their atmospheric concentration in the recharge water; (2) small bubbles of air can become enwater, (2) simal bubbles of all can become entrapped by recharge water at the unsaturated-saturated interface and later may dissolve in the groundwater under increased hydrostatic pressure in the saturated zone; (3) biochemical or chemical processes that produce or consume one or more of the dissolved gases, such as consumption of oxygen the dissolved gases, such as consumption of oxygen by oxidation reactions or production of nitrogen by denitrification reactions; (4) radioactive isotope decay in the aquifer rocks that produces trace gas concentrations such as Ar-40, which are released into the groundwater; and (5) degassing from deeper parts of the Earth's crust. Evidence is presented of a does present business. sented of a deep crustal source of common gases in the Appalachian region based on the reported nitrogen, oxygen and argon concentrations dissolved trogen, oxygen and argon concentrations dissolved in groundwater. Measured concentrations of N2 and Ar in water from wells and springs along the Appalachian mountain chain in the eastern USA show large excesses relative to the expected equilibrium values with air. In several formations, water samples taken along the flow gradient show water samples taken along the How gradient show an increase in the excess N2 and Ar with depth. The Ar/N2 ratios in these water samples are close to 35, indicating that the excess of Ar and N2 originate in deep-seated (at least several km depth) meteoric or sea water which may have reached the critical point of water. (Agostine-PTT) W91-09709

## HYDROCHEMICAL CHARACTERIZATION OF THE WATER DYNAMICS OF A KARSTIC

Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines

Journal of Hydrology JHYDA7, Vol. 121, p 103-117, December 1990. 7 fig, 35 ref.

Descriptors: \*Groundwater movement, \*Karst, \*Karst hydrology, \*Water chemistry, Bicarbonates, Calcium, Flow characteristics, Geochemistry, Geomorphology, Hydrologic data, Infiltration, Model studies, Sedimentation.

A karstic system can be characterized by its karsto-A karstic system can be characterized by its karsto-genesis, its geomorphology or by its contemporary dynamics. For this goal it is necessary to study its hydrologic processes which are governed by func-tions of input, transfer and output. Study of hydro-logical processes can be done by discharge analysis at the outlets of the system. For inaccessible sys-tems it is necessary to utilize other techniques such as hydrochemistry. Chemical analyses have been carried out in the Foussoubie karstic system in France to understand the origin and circulation of France to understand the origin and circulation of its water flow. These analyses were made during two different time scales, a whole hydrological cycle, and a flood. The evolution of the chemical composition of the water and particularly the bicarbonate/calcium ratio permit the identification of the kind of infiltration which contributes to the of the kind of infiltration which contributes to the subterranean flow. The role of point infiltration was estimated during the different hydrologic events occurring in the karstic system. Although concentrated infiltration contributes actively to subterranean flow during the high-water stage, it may be preponderant during a sharp flood event. Despite the fact that flood events represent a short period of the hydrologic cycle, their effects on the karstic system should not be underestimated, especially regarding sediment modification. A qualitative model has been set up to describe the degree of the contribution of infiltration to subterranean discharge. Interactive hydrologic and hydrobiolodischarge. Interactive hydrologic and hydrobiologic studies should allow a better understanding of

the physical and biological components which condition geochemical cycles. (Agostine-PTT) W91-09714

CONTAMINATION OF SOIL AND GROUND-WATER BY AUTOMATIC TRANSMISSION FLUID: SITE DESCRIPTION AND PROBLEM ASSESSMENT

General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W91-09716

USE OF ISOTOPE FRACTIONATION OF SULFATE-SULFUR AND SULFATE-OXYGEN TO ASSESS BACTERIAL DESULFURICATION IN A SANDY AQUIFER.

A SANDY AQUIFER. Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
O. Strebel, J. Bottcher, and P. Fritz.
Journal of Hydrology JHYDA7, Vol. 121, p 155172, December 1990. 11 fig, 26 ref.

Descriptors: \*Aquifers, \*Desulfurization, \*Groundwater chemistry, \*Groundwater movement, \*Isotope fractionation, \*Sulfur compounds, Denitrification, Hydraulic properties, Kinetics, Lignite, Microbial degradation, Monitoring wells, Nitrates, Oxidation, Recharge, Sand, Separation techniques, Water chemistry.

The unconfined aquifer of the 'Fuhrberger Feld' consists of 20-30 m sands and gravelly sands with unevenly distributed reduced sulfur compounds and small lignitic pebbles. In a vertical direction two hydrochemically different zones with specific solute transfermations are research. solute transformations are present, an upper por-tion with bacterial denitrification (with reduced sulfur compounds as electron donors) and a deeper portion with hydrochemical indications of reduc-tion of aqueous sulfate. In the study area ten multi-level groundwater sampling wells were installed. Sampling and interpretation was based on a two-Sampling and interpretation was based on a two-dimensional vertical-plane groundwater flowner and on the knowledge of the landuse upgradient of the multilevel wells. The concentration and isotop-ic composition of the sulfate at the entrance into the zone of sulfate reduction is controlled by sul-fate of groundwater recharge as well as sulfate formed during denitrification. The recharge-sulfate shows clear landuse specific differences in concen-tration and isotopic composition. In the denitrificasnows ctear inatures specific unterences in concentration and isotopic composition. In the dentirifica-tion zone no significant sulfur isotope fractionation occurs during oxidation of reduced sulfur. The oxygen-isotopic composition of the newly formed sulfate ('denitrification-sulfate') depends on the O-18 content of nitrate acting as an oxygen donor and on the O-18 content of groundwater in which the oxidation occurs. In the zone of sulfate reduction, both the S-34 and O-18 values of the residual sulfate increase with decreasing sulfate concentra-tions thus proving the existence of bacterial reduction of the aqueous sulfate. Data on concentration and isotopic composition of sulfate and on the hydraulically derived groundwater age are used for kinetic considerations. The bacterial reduction can be considered as first-order with a half-life between 75 and 100 years. (Author's abstract) W91-09717

## CONCEPTUAL AND COMPUTATIONAL ASPECTS OF THE MIXING CELL METHOD TO DETERMINE GROUNDWATER RECHARGE COMPONENTS.

Botswana Univ., Gaborone. Dept. of Geology. A. Gieske, and J. J. De Vries. Journal of Hydrology JHYDA7, Vol. 121, p 277-292, December 1990. 3 fig. 3 tab, 23 ref, 2 append.

Descriptors: \*Groundwater movement, \*Groundwater recharge, \*Mixing cell method, \*Tracers, Algorithms, Mathematical studies, Regression analysis, Reviews, Statistical methods. Regression

The mixing cell method to determine spatial re-charge distributions with the use of environmental isotopes and geochemical species was previously formulated as a quadratic programming problem, i.e. with a quadratic objective function subject to ear constraints. Conceptual and computational

aspects of the mixing cell method are critically reviewed, and an alternative formulation is given in terms of general linear regression theory, bring-ing it in line with the statistical framework devel-Wagner and Gorelick. For the impl tation of the alternative solution method the Singular Value Decomposition (SVD) algorithm is suggested which provides information about the exist gested which provides mornation about the exist-ence of a unique solution, makes it possible to deal with ill-conditioned problems, and finally also pro-vides the variances and co-variances of the calculated flow parameters. The theory and the SVD algorithm are illustrated with two simple examp one of which is the eastern Botswana situation. It is shown that in convex cases with positive semi definite singular matrices, quadratic programming may lead to solutions which are not unique and could therefore possibly ignore linear dependen-cies in the design matrix. The SVD algorithm delivers an adequate diagnosis in such circumstances. (Author's abstract) W91-09723

## CHEMICAL AND ISOTOPIC EVIDENCE FOR HYDROGEOCHEMICAL PROCESSES OC-CURRING IN THE LINCOLNSHIRE LIME-

Birmingham Univ. (England). School of Earth Sci-

P. K. Bishop, and J. W. Lloyd. Journal of Hydrology JHYDA7, Vol. 121, p 293-320, December 1990. 12 fig, 4 tab, 58 ref.

Descriptors: \*Geochemistry, \*Groundwater chemistry, \*Hydrogeology, \*Limestone, \*Stable isotopes, \*Water chemistry, Aquifers, Calcium carbonate, Carbonates, Hydraulic gradient, Hydrogen ion concentration, Iodides, Methane, Model studies, Nitrates, Oxidation, Soil water, Sulfates.

Over 150 groundwater samples from the Lincolnshire Limestone have been analyzed for pH, major ions and delta C-13 ratios. Where possible, field Eh and iodide concentrations were measured and methane concentrations were determined for samples. Stable isotope ratios were determined for soil and rock carbonate samples. A system of zonation allows the division of hydrogeochemical proc-esses occurring in the aquifer. The use of isotope and hydrochemical data in modeling exercises en-ables the re-evaluation and possible enhancement of the understanding of hydrogeochemical process-es. The carbonate chemistry of outcrop ground-waters is explained by calcite saturation being achieved under open-system conditions in the soil zone, delta C-13 ratios in the range -15.99 to -10.57 zone, ueta Cristatos in the range 11.379 to 10.37 ppt may be generated from a stoichiometric reaction with possible additional partial and/or simultaneous exchange with soil CO2 or carbonate. The isotopic composition of soil carbonate shows the effects of precipitation from soil waters. The in-congruent dissolution of primary depositional limestone carbonate results in increasing magnesium and strontium concentrations and increasing delta and strontium concentrations and increasing delta C-13 ratios for the groundwaters with flow down the hydraulic gradient. As a result of incongruent dissolution, secondary calcite may be precipitated onto fissure surfaces. Significant nitrate and sulfate reduction in non-saline groundwaters is not sup-ported by the results of hydrochemical and isotope modeling exercises. However, sulfate reduction and methane fermentation may be affecting the isotope and chemical compositions of saline groundwaters. Sodium-calcium ion exchange leads groundwaters. Sodium-calcium ion exchange leads to limited calcite dissolution deep in the aquifer, but the evolution of these groundwaters is con-fused by the uncertain effects of oxidation of organic carbon and mixing with a saline end-member solution. (Author's abstract) W91-09724

#### ESTIMATION OF NATURAL GROUNDWAT-ER RECHARGE IN THE KAROO AQUIFERS OF SOUTH AFRICA.

Orange Free State Univ., Bloemfontein (South Africa). Inst. for Groundwater Studies. G. J. Van Tonder, and J. Kirchner.

Journal of Hydrology JHYDA7, Vol. 121, p 395-419, December 1990. 8 fig, 1 tab, 46 ref.

## Group 2F-Groundwater

Descriptors: \*Aquifers, \*Estimating, \*Groundwater recharge, \*Recharge, \*Semiarid climates, \*South Africa, Aeration zone, Data collections, Mathematical studies, Model studies, Natural recharge, Nuclear moisture meters, Saturation zone, Scillagues, Scornivistus. Soil water, Storativity.

A 3-year project, to study the natural groundwater recharge of aquifers in the semi-arid Karoo formations of South Africa, was undertaken. Two typical Karoo aquifers, at Dewetsdorp and De Aar, were selected for study purposes. Data were collected from both the saturated and unsaturated zone. Neutron probe measurements showed that zone. Neutron probe measurements showed that there was no increase in the water content beneath a depth of approximately 1 m below the surface. Even with the exceptionally high rainfall in February 1988, neutron measurements indicated that very little soil matrix flow occurred, which implied that most of the recharge occurred along preferred pathways. A triangular finite element network was used to determine the relative saturated volume fluctuations (SVE) of the aquifers from ed volume fluctuations (SVF) of the aquifers from the observed water level changes over a period of time, which allowed determination of the storatitime, which allowed determination of the storativity S and the recharge. The main advantage of the method lies in determining recharge and storativity which are both unknowns in the water balance equation and which both contribute to the water-level response. The SVF method showed that the recharge in the Karoo formations of South Africa varies between 2 and approximately 5% of the annual rainfall. In areas which are overlain by a thick soil cover, the recharge is less than 3%, while recharge in hilly areas with a thin soil cover may be of the order of 5%. (Author's abstract) W91-09730

DETERMINING THE LENGTH OF CONFINED AQUIFER ROOF EXTENDING UNDER THE SEA BY THE TIDAL METHOD.

Department of Hydrogeology and Engineering Geology, China University of Geoscience, Wuhan, Hubei Province, China. L. Guomin, and C. Chongxi. Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 97-104, February 1991. 4 fig, 1 tab, 5 ref.

Descriptors: \*Aquifer characteristics, \*Confined aquifers, \*Groundwater movement, \*Saline water intrusion, \*Saline-freshwater interfaces, \*Tidal efects, Aquifer systems, Coastal aquifers, Groundwater level, Leakage, Water level fluctuations.

The main task in studying saline intrusion into an aquifer is to determine the position of the saline water-freshwater interface. For a confined aquifer this position is determined mainly by the roof length of the aquifer extending under the sea. This information can be obtained from fluctuations of the groundwater level caused by tidal fluctuations of the sea. A mathematical model of confined groundwater-level fluctuations was constructed on the condition that the roof length is finite. Taking account of the continuity of flow between the inland and offshore aquifers allows a general for-mula to be calculated for the groundwater-level fluctuations in terms of the tidal fluctuations and the length of the confined aquifer under the sea. The actual roof length can be computed by com-parison of the observed groundwater-level fluctua-tions with those computed by the formula under various assumptions concerning the roof length. The method was applied to an aquifer on the Beihai Peninsula, in the Guangxi province of China. It was found that the method has certain limitations: (1) to be successful the waves must be propagated inland from a relatively straight shoreline, and it is necessary that the aquifer is confined or semiconfined with little vertical leakage; (2) it depends on a dominant component in the tides so that a single value of the period can be used without introducing large errors; and (3) it is nec-essary to obtain the sinusoidal components of the tidal fluctuations and the groundwater-level fluctu-ations from the tidal chart. (Author's abstract) W91-09783

RICHARDS' ASSUMPTIONS AND HASSLER'S PRESUMPTIONS.

nonwealth Scientific and Industrial Research

Organization, Canberra (Australia). Div. of Environmental Mechanics W. Rose.

Transport in Porous Media TPMEEI, Vol. 6, No. 1, p 91-99, February 1991. 14 ref.

Descriptors: \*Groundwater movement, \*Multiphase flow, \*Permeability, \*Richards equation, \*Saturated flow, \*Soil water, Hydraulic conductivity, Hydrodynamics, Interstitial water, Laboratory methods, Porous media

Investigation suggests that certain assumptions must be implicitly made whenever the well-known and much admired Richards-Hassler methodology (for investigating flow phenomena in multiphase saturated porous media) is being employed. When-ever the propositions that are being taken for granted are not fully stated, however, they can take on the appearance of being presumptions. An analysis has been made, therefore, to clarify the differences between what historically has been said, and what still needs to be said, about the rationale that underlies the sense of the always intriguing but sometimes misunderstood Richards-Hassler conceptualizations. The relevance of much that is done in laboratories today would be in doubt unless certain central ideas can be employed as working hypotheses. One set of such ideas involves four propositions as follows: (1) the conductivity afforded by porous media to fluid phases that tivity afforded by porous media to fluid phases that only partially occupy the pore space is greatly affected by the spatial geometry of the domain occupied by the interstitial fluids in question; (2) procedures are available by which the desired interstitial configurations of the fluid phases can be obtained as the static equilibrium end-points of experiments where capillary and gravity forces come into balance; (3) the end-point configurations of the interstitial fluids just described can then be preserved under laboratory conditions as the dypreserved under laboratory conditions as the dy-namics of steady multiphase flow processes are subsequently investigated; and (4) viable ways can be found to infer useful information about unsteady-state phenomena from the steady-state data already obtained. These four propositions are, in fact, paraphrases of what are occasionally attrib-uted to Richards and Hassler, and of what have been loosely called presumptions when, more pre-cisely, they could have been designated later-day embellishments and adornments. (Fish-PTT) W91-09794

LEAKAGE OF CLOGGED CHANNELS THAT PARTIALLY PENETRATE AQUIFERS.

Miami Univ. Coral Gables, FL. Dept. of Civil and Architectural Engineering.

For primary bibliographic entry see Field 2E.
W91-09812

GROUND-WATER PUMPAGE FROM THE GROUND-WATER FUMFAGE FROM THE GULF COAST AQUIFER SYSTEMS, 1960-85, SOUTH-CENTRAL UNITED STATES. Geological Survey, Reston, VA. Water Resources

T. O. Mesko, T. A. Williams, D. J. Ackerman, and

A. K. Williamson.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4180, 1990. 177p, 15 fig, 11 tab, 84 ref, 5 pl.

Descriptors: \*Alabama, \*Arkansas, \*Florida, "Gulf Coastal Plain, \*Kentucky, \*Louisiana, \*Mis-sissippi, \*Missouri, \*Pumpage, \*Regional Aquifer System Analysis, \*Tennessee, \*Texas, Coastal lowlands aquifer system, Mississippi embayment aqui-fer system, Texas coastal uplands aquifer system.

The gulf coast aquifer systems of the south-central United States were divided into 10 model layers for regional analysis of groundwater flow. Detailed estimates of 1980 fresh water pumpage were made for each layer underlying each 25-squaremile area of the model grid. Total pumpage by county was compiled at 5-year intervals for the period 1960.85 Total groundwater pumpage by county was compiled at 5-year intervals for the period 1960-85. Total groundwater pumpage by county for years other than 1980 generally was assigned to layers and 25-square-mile areas in the same proportion as total pumpage by county in

1980. Total groundwater pumpage in the Gulf 1980. Total groundwater pumpage in the Guit coast aquifer systems increased by a factor of 2.5 during 1960-80, from 3,800 to 9,500 million gallons/day but decreased by 7% to 8,900 million gallons/day in 1985. This was consistent with a nationwide decline of about 12% between 1980 nationwide decline of about 12% between 1980 and 1985. About 12% of all ground water pumped in the United States is withdrawn from aquifers in the study area. Harris County, Texas had the largest total pumpage of groundwater during 1960-85 of all counties in the study area. A total of 380 million gallons/day of ground water was pumped in Harris County during 1985. Of that total, 360 million gallons/day was pumped mostly for public supply and industry combined. The largest withdrawal for irrigation occurred in Poinsett and Lonoke Counties, Arkansas, where 300 million gallons/day in each county was pumped for irrigation during 1985. The total number of 25-square mile areas with ground-water pumpage equal to or during 1985. The total number of 25-square mile areas with ground-water pumpage equal to or greater than 0.5 million gallons/day increased from about 1,500 during 1960 to about 2,500 during 1985. However, total groundwater pumpage increased at a proportionately faster rate, indicating that pumpage increased most rapidly in areas where groundwater supplies had been developed previously. (USGS) W91-09816

METHODS FOR SELECTION AND HYDRO-LOGIC DESCRIPTION OF POTENTIAL LAND-FILL SITES IN SOUTHEASTERN SAN DIEGO COUNTY, CALIFORNIA.

Geological Survey, San Diego, CA. Water Resources Div.

For primary bibliographic entry see Field 5E. W91-09817

WATER-LEVEL MAPS OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1987.

Geological Survey, Little Rock, AR. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09818

HYDROGEOLOGIC UNIT MAP OF THE PIED-MONT AND BLUE RIDGE PROVINCES OF NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources

For primary bibliographic entry see Field 7C. W91-09822

EFFECTS OF CHANNEL MODIFICATIONS ON THE HYDROLOGY OF THE CHICOD CREEK BASIN, NORTH CAROLINA, 1975-87. Geological Survey, Raleigh, NC. Water Resources

For primary bibliographic entry see Field 2E. W91-09823

INTERRELATIONSHIPS BETWEEN CARBONATE AQUIFER SHALLOW CONDUIT FLOW AND POLLUTION POTENTIAL FROM SURFACE ACTIVITIES.

Kentucky Water Resources Research Inst., Lexington.

For primary bibliographic entry see Field 5B. W91-09827

ARCHIVING OF DEEP PERCOLATION MODELS, DATA FILES, AND CALCULATED RECHARGE ESTIMATES FOR THE COLUM-BIA PLATEAU REGIONAL AQUIFER SYSTEM, WASHINGTON, OREGON, AND

Geological Survey, Tacoma, WA. Water Resources Div.

J. J. Vaccaro, and H. H. Bauer.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-186, 1990. 13p, 2 fig, 3 tab, 2 ref. Descriptors: \*Data storage and retrieval, \*Ground-water recharge, \*Hydrologic data, \*Model studies, \*Regional Aquifer System Analysis, Archive, Computer models, Deep percolation, Magnetic tape, Numerical models, Regional aquifer systems.

Computer files used in a daily deep percolation model to calculate recharge estimates for the Columbia Plateau regional aquifer system in parts of Washington, Oregon, and Idaho are obtainable on magnetic tape from the U.S. Geological Survey. There are 53 files containing source codes of the models used for 53 zones and one file containing the source code for an inverse I support projection. the source code for an inverse Lambert projection. Basic input data and model output are each contained in 103 files, 53 files for predevelopment and 50 files for current land-use conditions. Other files contain data for: (1) model grid definition; (2) line printer output-map configurations; (3) soil types; (4) land uses; (5) annual irrigation application rates; (6) land-surface altitudes, slopes, and aspects; (7) (6) land-surface attitudes, stopes, and aspects; (7) annual average precipitation values; (8) daily stream discharges; (9) monthly estimates of baseflow to streams; (10) locations of precipitation weather stations; (11) locations and altitudes of temperature weather stations; (12) long-term average July minimum and maximum air temperatures at temperature weather stations; (13) mean daily precipitation data at 103 weather stations for 22 years; (14) mean daily maximum air temperatures at 89 weather sites for 22 years; and (15) mean daily minimum air temperatures at 89 sites for 22 years. (USGS) W91-09828

RESULTS OF TEST DRILLING AND HYDRO-RESULTS OF TEST DRILLING AND HYDRO-LOGIC MONITORING IN THE INDIAN BATHTUB AREA, OWYHEE COUNTY, SOUTHWESTERN IDAHO, JANUARY 1989 THROUGH SEPTEMBER 1990. Geological Survey, Boise, ID. Water Resources

Div.

For primary bibliographic entry see Field 7C. W91-09830

ESTIMATES OF GROUND-WATER RE-CHARGE TO THE COLUMBIA PLATEAU RE-GIONAL AQUIFER SYSTEM, WASHINGTON, OREGON, AND IDAHO, FOR PREDEVELOP-MENT AND CURRENT LAND-USE CONDI-TIONS TO THE PROPERTY OF THE PROPERTY

Geological Survey, Tacoma, WA. Water Resources Div.

sources Div.
H. H. Bauer, and J. J. Vaccaro.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4108, 1990. 37p, 2 plates, 6 fig, 11 tab, 16 ref.

Descriptors: \*Columbia Plateau, \*Groundwater recharge, "Groundwater resources, "Infiltration, Regional Aquifer System Analysis, "Washington, Arid-zone hydrology, Deep percolation, Evapo-transpiration, Percolation, Soil water, Soil-waterplant relationships.

Long term time-averaged groundwater recharge estimates for predevelopment and current land-use conditions were simulated for the 1956-77 period for the Columbia Plateau regional aquifer system analysis study using a deep-percolation model. Recharge estimates were made for individual cells within 53 zones ranging in size from 20 to 2,392 square miles. The deep percolation model uses precipitation, temperature, streamflow, soils, land use, and elevation data to compute transpiration, soil evaporation, snow accumulation, snowmelt, soil evaporation, snow accumulation, snowmeit, sublimation, and evaporation of intercepted moisture. Daily changes in soil moisture, plant interception, and snowpack are computed and accumulated. Deep percolation is computed when soil moisture exceeds field capacity. The total recharge rate for predevelopment land-use conditions for the 53 modeled zones was estimated to be 2,600 cu ft/sec or 1.65 in/yr on average. Recharge for current land use was estimated to be 6,100 cu ft/sec or 3.88 in/yr on average. Recharge for areas outside of the zones but within the study area was estimated by a second-order polynomial regression equation relat-ing the long-term zone recharge estimates to average annual precipitation. Estimates of average re-

charge rate for the total area within the ground-water model boundaries (32,800 sq mi) for predevelopment and current land-use conditions were 6,000 cu ft/sec (2.48 in/yr) and 9,500 cu ft/sec (3.93 in/yr), respectively. (USGS) W91-09831

RECHARGE RATES AND AQUIFER HYDRAU-LIC CHARACTERISTICS FOR SELECTED DRAINAGE BASINS IN MIDDLE AND EAST TENNESSEE

Geological Survey, Nashville, TN. Water Re-For primary bibliographic entry see Field 2E. W91-09833

GROUND-WATER AVAILABILITY AND QUALITY IN EASTERN BERNALILLO COUNTY AND VICINITY, CENTRAL NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div. G. F. Kues.

G. E. Kues. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 89-4127, 1991. 82p, 30 fig, 5 tab, 15 ref.

Descriptors: \*Groundwater availability, \*New Mexico, \*Water quality, \*Water resources data, Fluorides, Fracture permeability, Groundwater level, Nitrates, Water chemistry.

Eastern Bernalillo County, New Mexico is a moun Eastern Bernaulo County, New Mexico is a moun-tainous area undergoing urbanization. Possible groundwater declines and groundwater degrada-tion as a consequence of development needed to be studied before future development is planned. Groundwater availability depends on the lithology of the water yielding unit and nearness to faults. Depth to water is generally 200 ft or less. Precipitation, the only source of recharge to the ground-water system, is greatest at and near mountain water system, is greatest at an incare mountain crests where most recharge probably occurs, but recharge is occurring in other places as well. A direct correlation appears to exist between changes in precipitation and water levels in the north-central part of the area. The time of response between the two appears to be approximately 2-1/2 years. Water level declines since the late 1950's have been almost entirely restricted to wells com-pleted in shale units. In areas where clastic materials crop out, short-term changes in water levels of as much as 117 ft in 4 months have occurred, as much as 11.7 in 4 months have occurred, causing temporary water shortages. Water samples from wells in Tijeras Canyon had nitrate-nitrogen concentrations of as much as 30 mg/L, and water from the new community supply well in Chilli had 16 mg/L. Of wells resampled since the early 1960's, a well near Sandia Park had the largest increase in nitrate-nitrogen concentrations, from 1.6 to 7.8 mg/L. Most groundwater in the study area is acceptable for domestic use. (USGS) W91-09838

GROUND-WATER LEVELS AND QUALITY AT CREX MEADOWS WILDLIFE AREA, BURNETT COUNTY, WISCONSIN. Geological Survey, Madison, WI. Water Resources Div.

G. L. Patterson. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4129, 1990. 19p, 13 fig, 2 tab, 5 ref.

Descriptors: \*Groundwater. \*Groundwater level, \*Wetlands, Areal precipitation, Discharge hydrographs, Surface-groundwater relations.

Crex Meadows Wildlife Area encompasses more than 30,000 acres of brush prairie, wetland, and forest in Burnett County, Wisconsin. Abovenormal groundwater levels that flooded farm fields and basements near the Crex Meadows Wildlife Area during 1984 caused concern among landowners and State officials. Data from an inventory of groundwater levels from the 1930's were compared with water data from 1986 and 1987. The comparison indicates that water levels in 1986

were 5 to 10 ft higher than in the 1930's. Hydrographs of water levels from 1985 through 1987 indicate a rise in 1985 and 1986 followed by an abrupt decline in 1987. Local precipitation records andicate that the Crex Meadows area had received above-normal precipitation during 1981-86. Precipitation in 1987 was below normal. Regional data, including groundwater levels from long-term observation wells at Webster and Milltown (13 miles northeast and 20 miles southeast of Crex Meadows) and discharge records for 2 stations on the St. Croix River, indicate that groundwater levels and surface water discharge were the high-est on record during 1986. Cumulative departure from mean annual precipitation at Danbury and St. Croix Falls indicates that the high-water levels in Croix Falls indicates that the high-water levels in 1986 were preceded by several years of above-normal precipitation throughout northwestern Wisconsin. Because high groundwater and surface water levels developed in northwestern Wisconsin throughout 1986, it is likely that precipitation variations were primarily expensible for the levels. ations were primarily responsible for the local flooding and above-normal groundwater levels. (USGS) W91-09839

NUTRIENTS, PESTICIDES, SURFACTANTS, AND TRACE METALS IN GROUND WATER FROM THE HOWE AND MUD LAKE AREAS UPGRADIENT FROM THE IDAHO NATION-AL ENGINEERING LABORATORY.

Geological Survey, Idaho Falls, ID. Water Re-

For primary bibliographic entry see Field 5B. W91-09842

GEOLOGY, HYDROLOGY, AND WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM IN VOLUSIA COUNTY, FLORIDA. Geological Survey, Tallahassee, FL. Water Resources Div.

G. G. Pheips.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4069, 1990, 67p, 23 fig, 12 tab, 51 ref. USGS Project No.

Descriptors: \*Groundwater resources, \*Geohydrology, \*Water quality, \*Water pollution sources, \*Florida, Water use.

The surficial aquifer system in Volusia County, Florida comprises Miocene to Holocene age sand, sandy clay, shell, and calcareous silty clay, that together range in thickness from about 40 to more than 100 ft. Locally, the surficial aquifer system can be subdivided into upper and lower permeable zones separated by 5 to 10 ft of discontinuous clay or silty sand. Water use from the surficial aquifer system in 1987 totaled about 4.2 million gal/day. The water level can be 30 ft or more below land surface, but is less than 10 ft below land surface on terraces and in the interridge area near the St. Johns River. Important recharge areas are along the De Land Ridge and the western part of the Talbot Terrace; some recharge occurs along the Atlantic Coastal Ridge. The recharge rate in the areas probably ranges from 9 to 18 inches/year, whereas in nonridge areas the rate is about 0 to 8 whereas in nonridge areas the rate is about 0 to 8 inches/year. Laboratory hydraulic conductivities for surficial aquifer system core samples ranged from 0.000076 to 0.34 ft/day with a median of 0.010 ft/day, and field hydraulic conductivities ranged from 0.030 to 12.8 ft/day with a median of 0.029 ft/day. The transmissivity of the lower permeable zone in Oak Hill (southeastern Volusia County), calculated from an aquifer test, is 1,200 sq. ft/day, and the corresponding hydraulic conductions. ft/day, and the corresponding hydraulic conduc-tivity is about 30 ft/day. Chloride concentrations of water from wells tapping the upper permeable zone ranged from 1.2 to 15,000 mg/L; for the lower permeable zone, the range was from 5.7 to 340 mg/L. In both zones, nutrient concentrations at some sites were higher than would be expected for natural groundwater, indicating some effect from infiltrating surface water or from human activity. (USGS)

## **Group 2F—Groundwater**

SIMULATION OF GROUND-WATER FLOW AND POTENTIAL LAND SUBSIDENCE, AVRA VALLEY, ARIZONA. Geological Survey, Tucson, AZ. Water Resources

DIV.
R. T. Hanson, S. R. Anderson, and D. R. Pool.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Water-Resources Investigations Report 90-4178, 1990. 41p, 20 fig, 2 tab, 53 ref. USGS Project No.

Descriptors: \*Geohydrology, \*Compaction, \*Stress, \*Subsidence, \*Groundwater, \*Model studies, \*Arizona, \*Pima County, \*Pimal County, Extensometer, Computer models, Aquitards, Aquifer characteristics, Lower Santa Cruz Valley, Avra Valley.

A numerical groundwater flow model of Avra Valley, Pima and Pinal Counties, Arizona, was developed to evaluate predevelopment conditions in 1940, groundwater withdrawals from 1940 through 1984, and potential land subsidence from 1985 through 2024. The components of groundwater inflow and outflow for steady-state simulation used 18,900 acre-ft with negligible amounts of constant problems in 1940. Transient state was simulative. areal recharge in 1940. Transient state was simulated using 4.4 million acre-ft of pumpage resulting in 3.4 million acre-ft of pumpage resulting in care-ft of the water withdrawn from aquifer storage from 1940 through 1984. The net differter storage from 1940 inrough 1954. The net difference of 1.0 million acre-fi is attributed to increased recharge from irrigation return flow and infiltration of streamflow and sewage effluent in the northern half of the valley after 1964. Increased recharge was the source of 40% of pumpage from 1965 through 1984 in this area. Increased recharge contribute to decreased water lead decline receiver. contributed to decreased water level decline rates contributed to decreased water level decline rates after 1964 and water level recoveries after 1977 in the northern half of the valley. Simulations indicate that maximum potential subsidence for 1985 through 2024 ranges from 0.9 ft for an inelastic specific storage of 0.000010 to 14.7 ft for an inelastic specific storage of 0.00015 sq ft. Pumpage and recharge rates from 1973 through 1977 and a preconsolidation stress threshold of 100 ft were assumed for these simulation. The subsidiest resistance in the stress threshold of 100 ft were assumed for these simulation. consolidation stress threshold of 100 if were assumed for these simulations. The projections simulated 4.2 million acre-ft withdrawn from aquifersystem storage from 1985 through 2024. About 1 to 10% of this water will come from a permanent reduction in aquitard storage. (USGS) W91-09847

SELECTED REFERENCES FOR THE PUGET-WILLAMETTE LOWLAND REGIONAL AQUI-FER-SYSTEM ANALYSIS, PUGET SOUND LOWLAND, WASHINGTON. Geological Survey, Tacoma, WA. Water Re-

sources Div. For primary bibliographic entry see Field 10B. W91-09850

GROUND-WATER PUMPAGE FROM THE CO-LUMBIA PLATEAU REGIONAL AQUIFER SYSTEM, WASHINGTON, 1984. Geological Survey, Tacoma, WA. Water Re-

sources Div.

For primary bibliographic entry see Field 6D. W91-09851

EXTENT AND SOURCE OF ORGANIC SOLVENTS IN GROUND WATER IN THE ARGONNE ROAD AREA NEAR SPOKANE, WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 5B. W91-09852

POTENTIAL FOR GROUND-WATER DEVELOPMENT IN CENTRAL VOLUSIA COUNTY,

FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div J. O. Kimrey.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4010, 1990. 31p, 4 fig, 1 tab, 7 ref.

Descriptors: \*Potential water supply, \*Water resources data, \*Groundwater resources, Recharge, Potentiometric level, Drawdown, Depression

The Upper Floridan aquifer is the source of all public water supplies in Volusia County, east-central Florida. All freshwater in the Upper Floridan in Volusia County is derived from recharge within in Volusia County is derived from recharge within the county, and most discharge from the aquifer occurs at, or contiguous to, county boundaries. Brackish water is present in the discharge areas that virtually surround the county. The surficial aquifer overlies the Upper Floridan throughout the county. Together the two aquifers constitute a system that is full and rejecting water from the surficial aquifer to surface runoff and evapotranspiration in the wetlands environment of the Talbot Terrace. Recharge to the Upper Floridan aquifer occurs where there is a downward head gradient between the water table in the surficial gradient between the water table in the surficial aquifer and the potentiometric surface of the Upper Floridan aquifer. The two-aquifer system in central Volusia County comprises a potential re-charge area that would function as a high-rate recharge area if water were withdrawn from the Upper Floridan for use, thereby lowering the po-tentiometric surface and inducing some of the water now being rejected from the surficial aquifer water now being rejected from the surfacia aquiter to leak downward into the Upper Floridan. By decreasing the rejected recharge by the amount of capture, more water would be available for use. The potential recharge area is underlain by a large reserve of freshwater in an area that is currently only slightly stressed by withdrawals. (USGS) W91-09853

QUALITY OF GROUND WATER IN CLARK COUNTY, WASHINGTON, 1988. Geological Survey, Tacoma, WA. Water Re-

sources Div. For primary bibliographic entry see Field 5B. W91-09854

GROUND-WATER RECHARGE IN FLORIDA A PILOT STUDY IN OKALOOSA, PASCO, AND VOLUSIA COUNTIES.

Geological Survey, Tallahassee, FL. Water Resources Div. For primary bibliographic entry see Field 4B. W91-09855

HYDROLOGY OF HEBER AND ROUND VALLEY, WASATCH COUNTY, UTAH, WITH EMPHASIS ON SIMULATION OF GROUND-WATER FLOW IN HEBER VALLEY. Geological Survey, Salt Lake City, UT. Water

Geological Survey, Salt Lake City, UT. Water Resources Div. D. M. Roark, W. F. Holmes, and H. K. Shlosar. Available from U.S. Geological Survey, Room 1016, Administration Building, 1745 W. 1700 S., Salt Lake City, Utah 84104. Utah Department of Natural Resources, Salt Lake City, Technical Pub-lication No. 101, 101p, 25 fig, 10 tab, 25 ref.

Descriptors: \*Groundwater movement, \*Water resources data, \*Utah, \*Wasatch County, Groundwater, Hydrologic models, Heber, Round Valley.

An investigation of the hydrologic system in Heber and Round Valleys was conducted to im-prove understanding of the surface-water and groundwater hydrology and the effects of valley-fill deposits, but the principal groundwater reser-voir is in the unconsolidated valley-fill deposits. Recharge to unconsolidated valley-fill deposits in Heber Valley from unconsumed irrigation water, stream infiltration, subsurface inflow from consolidated rocks, and precipitation is estimated to be 154 cu ft/sec. Discharge is by leakage to Deer Creek Reservoir, by springs and seeps, by seepage to the Provo River and other streams, by evapo-transpiration, and by pumping from wells. Re-charge to the unconsolidated valley-fill deposits in Round Valley from stream infiltration, precipitation, unconsumed irrigation water and subsurface inflow from consolidated rocks is estimated to be 11 cu ft/sec. Discharge is by springs and seeps, by evapotranspiration, and by pumping from wells. Seasonal water-level fluctuations of as much as 30

ft occur primarily because of changes in recharge from unconsumed irrigation water. Water levels generally are highest during June or July when recharge from irrigation is at a maximum and lowest during the winter when irrigation is absent and recharge is at a minimum. A groundwater flow model was developed to simulate 1988-89 hydro-logic conditions in Heber Valley. Simulations indicate that decreased recharge to the unconsolidated valley fill deposits causes a decrease in discharge to springs and seeps, streams, and leakage to Deer Creek Reservoirs. (USGS) W91-09857

EVALUATION AND DESIGN OF GEOPHYSI-CAL MONITORING NETWORK FOR GROUNDWATER CONTAMINATION.

Nebraska Univ.-Lincoln. Dept. of Civil Engineer-For primary bibliographic entry see Field 7A.

W91-09861

W91-09865

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1990, VOLUME 2. GROUND WATER AND GROUND-WATER QUALITY RECORDS.

Geological Survey, Richmond, VA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09864

WATER RESOURCES DATA FOR MINNESO-TA, WATER YEAR 1989, VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN. Geological Survey, St. Paul, MN. Water Resources Div. For primary bibliographic entry see Field 7C.

GROUNDWATER CONTAMINATION IN THE

UNITED STATES. Geological Survey, Reston, VA. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-09866

COSTS OF GROUNDWATER CONTAMINA-

Environmental Protection Agency, Washington, For primary bibliographic entry see Field 5C. W91-09867

AGRICULTURAL CHEM GROUNDWATER QUALITY. CHEMICALS AND

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab. For primary bibliographic entry see Field 5B. W91-09868

PUBLIC POLICY PERSPECTIVE ON GROUNDWATER QUALITY.

Florida Univ., Gainesville. Dept. of Food and Resource Economics. For primary bibliographic entry see Field 6B.

W91-09869

KEY POLICY CHOICES IN GROUNDWATER QUALITY MANAGEMENT.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics. For primary bibliographic entry see Field 5G. W91-09870

COMMUNICATING WATER QUALITY RISK. Cornell Univ., Ithaca, NY. Dept. of Communica-

For primary bibliographic entry see Field 5G. W91-09871

## Groundwater-Group 2F

AGRICULTURAL BEST MANAGEMENT PRACTICES AND GROUNDWATER PROTEC-TION.

Ohio State Univ., Columbus. Dept. of Agronomy. For primary bibliographic entry see Field 5G. W91-09872

PROTECTING GROUNDWATER QUALITY BY MANAGING LOCAL LAND USE.
Wisconsin Univ.-Madison. Environmental Resources Center. For primary bibliographic entry see Field 5G. W91-09873

LIABILITY ISSUES IN GROUNDWATER QUALITY PROTECTION.

For primary bibliographic entry see Field 6E. W91-09874

BLAMELESS CONTAMINATION: NEW STATE LEGISLATION REGULATING LIABILITY FOR AGRICULTURAL CHEMICALS IN

FOR AGRICULTURAL CHEMICALS IN GROUNDWATER.
Georgia Agricultural Experiment Stations, Athens. For primary bibliographic entry see Field 6E. W91-09875

FARMER LIABILITY FOR PESTICIDE CONTAMINATION OF GROUNDWATER IN CONTAMINATION

Connecticut Univ., Storrs. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 6E.
W91-09876

GEOGRAPHIC INFORMATION SYSTEM FOR

GROUNDWATER PROTECTION PLANNING. Rhode Island Univ., Kingston. Dept. of Natural Resources Science.
For primary bibliographic entry see Field 7C. WQ1\_00883

AGRICULTURAL CHEMICALS IN GROUND-WATER: MONITORING AND MANAGEMENT

IN CALIFORNIA.
California Univ., Los Angeles. School of Public

For primary bibliographic entry see Field 5G. W91-09885

INTEGRATED APPROACH TO WATER RE-SOURCES MANAGEMENT: THE CARROLL COUNTY, MARYLAND STORY. Bureau of Water Resource Management, Carroll County, Maryland, 225 N. Center Street, Westmin-ster, Maryland 21157.

For primary bibliographic entry see Field 6A. W91-09888

IMPLEMENTATION ISSUES IN SPECIAL GROUNDWATER QUALITY PROTECTION AREAS.

Nebraska Univ., Lincoln. Dept. of Agricultural Economics. For primary bibliographic entry see Field 5G. W91-09891

GROUNDWATER QUALITY MANAGEMENT IN NEBRASKA'S CENTRAL PLATTE VALLEY. Nebraska Univ., Clay Center. For primary bibliographic entry see Field 5G. W91-09892

MICHIGAN GROUNDWATER SURVEY: A CO-OPERATIVE VENTURE OF LOCAL GOVERN-MENTS

Western Michigan Univ., Kalamazoo. Science for Citizens Center For primary bibliographic entry see Field 6E. W91-09894

LOCAL GOVERNMENTS COOPERATING TO PROTECT GROUNDWATER.

Minnesota State Planning Agency, St. Paul. For primary bibliographic entry see Field 5G. W91-09895

COORDINATED GROUNDWATER PROTEC-

CORDINATED GROUNDWATER PROTEC-TION IN HEBRON, CONNECTICUT. Connecticut Dept. of Environmental Protection, Hartford. Bureau of Water Management. For primary bibliographic entry see Field 5G. W91-09897

STORMWATER RUNOFF POLICY ON THE SPOKANE/RATHDRUM PRAIRIE AQUIFER. Panhandle Health District 1, Coeur d'Alene, ID. For primary bibliographic entry see Field 5G. W91-09898

WASTEWATER DISPOSAL AT FRUIT AND VEGETABLE PACKING FACILITIES IN DADE COUNTY, FLORIDA.

Department of Environmental Resources Management, Miami, FL. Agricultural Waste Program. For primary bibliographic entry see Field 5E.

NITRATE-NITROGEN LOSSES TO GROUND-WATER FROM RURAL AND SUBURBAN LAND USES.

Rhode Island Univ., Kingston. Dept. of Natural Resources Science For primary bibliographic entry see Field 5B. W91-09900

LOCAL LAND USE PLANNING FOR RURAL GROUNDWATER PROTECTION IN VERMONT AND NORTHERN NEW YORK.

Vermont Univ., Burlington. School of Natural Resources. For primary bibliographic entry see Field 5G. W91-09901

PROVIDING INFORMATION TO FARMERS FOR GROUNDWATER QUALITY PROTECTION.

IOWA Univ., Iowa City. Graduate Program in Urban and Regional Planning. For primary bibliographic entry see Field 5G. W91-09902

PATTERNS OF SOIL NITRATE AVAILABIL-ITY IN CORN PRODUCTION SYSTEMS: IM-PLICATIONS FOR REDUCING GROUNDWAT-ER CONTAMINATION.

Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B. W91-09903

LANDOWNER PERCEPTIONS OF SINK-HOLES AND GROUNDWATER CONTAMINA-TION

Iowa Natural Heritage Foundation, Des Moines. For primary bibliographic entry see Field 5G. W91-09904

NUTRIENT LOSS VIA GROUNDWATER DIS-CHARGE FROM SMALL WATERSHEDS IN SOUTHWESTERN AND SOUTH CENTRAL

Wisconsin Dept. of Natural Resources, Fitchburg. Bureau of Research. For primary bibliographic entry see Field 5B. W91-09905

LONG-TERM PATTERNS IN SPRING WATER QUALITY: AN APPROACH TO GROUNDWATER EDUCATION PROGRAMS FOR RURAL COMMUNITIES.

Virginia Polytechnic Inst. and State Univ., Blacksvirginia Polytectime Inst. and State Univ. Blacks-burg. Dept. of Fisheries and Wildlife Sciences. L. A. Heifirch, and D. L. Weigmann. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 332-335, 1990. 2 fig. 1 tab, 13 ref.

Descriptors: \*Chlorides, \*Education, \*Groundwat-Descriptors: "Chiorides, "Education, "Croundwater quality, \*Nitrates, \*Public participation, "Rural areas, "Spring water, \*Total dissolved solids, "Water quality monitoring, "Water quality trends, Analysis, Comparison studies, Geohydrology, Groundwater data, Septic systems, Water pollution control, Well water.

Comparisons of historical groundwater quality data with recent measurements from springs or wells offer a unique window through which longterm trends in water quality can be examined and readily understood by the public. Groundwater education programs for rural communities that in-corporate analysis and interpretation of long-term trends in water quality have several of the compotrends in water quanty have several of the compo-nents germane to a successful groundwater protec-tion program: (a) comparative spring surveys are responsive and credible to the public because sam-pling is conducted in nearby regions and can be done by local organizations, (b) the public better supports and understands the necessity of groundwater protection because people have an overview of water quality changes through time and these changes can be related to the hydrogeology of the area, and (c) citizens are involved in program design and evaluation. Current water quality sampling, collection of historical data and analysis of past and present land use practices can be accom-plished by residents of rural communities. Citizens can work cooperatively with technical and scien-tific consultants in conducting water quality analy-sis and data interpretation. (Feder-PTT) W91-09906

EXPERT OPINION AND GROUNDWATER QUALITY: THE CASE OF AGRICULTURAL DRAINAGE WELLS.

Minnesota Univ.-Duluth. Dept. of Geography. For primary bibliographic entry see Field 5B. W91-09907

USING THE CONSERVATION RESERVE PROGRAM TO PROTECT GROUNDWATER QUAL-ITY.

Economic Research Service, Washington, DC. For primary bibliographic entry see Field 5G. W91-09908

GROUNDWATER POLLUTION'S EFFECTS ON RESIDENTIAL PROPERTY VALUES, PORTAGE COUNTY, WISCONSIN. For primary bibliographic entry see Field 5C.

W91-09909

DIFFUSION IN SATURATED SOIL. I: BACK-GROUND.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering. For primary bibliographic entry see Field 5B. W91-09939

CHARACTERIZATION AND CONTROL OF SHALLOW GROUND WATER CONDITIONS. Leighton and Associates, Inc., Irvine, CA. M. H. S. Mortazavi, and B. R. Clark. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p D1-D7. 7 fig,

Descriptors: \*Data interpretation, \*Drainage, \*Geohydrology, \*Groundwater level, \*Groundwater movement, Caliche, California, Design critevalet movement, Cancile, Cantonia, Desgi citics, alto met, Groundwater data, Groundwater recharge, Hydraulic conductivity, Hydraulic gradient, Hydraulic structures, Infiltration, Mathematical studies, Piezometers, Piezometric head, Under-

Shallow groundwater has been a common problem in the historical development of lowland areas of Southern California. Local groundwater conditions, including seasonal variations in the water table, flow direction, and hydraulic (pressure) gradients, can be characterized by monitoring multilevel open-pipe hydraulic piezometers and analyz-ing piezometric head diagrams by plotting total (or

## Group 2F-Groundwater

piezometric) head versus elevation (or position) head. Based on this information, shallow groundnead. based on this information, snaflow ground-water can be analyzed to determine the scope of measures controlling shallow groundwater prob-lems by either applying the hydrologic equation or constructing a flow net for the area defined by recharge and discharge boundaries and the elevated groundwater in a project area. The simplified solutions employed in the design of control meassolutions employed in the design of control measures could be improved by a rigorous numerical analysis (e.g., finite element method), particularly when computer software is devised for the collection and preparation of data regarding characterization of groundwater conditions in accordance with piezometric head diagram analysis. Numerical analysis would take into account the anisotropic condition and spatial variation of hydraulic conductivity and hydraulic gradient within an investi-gation site. In addition, underdrains can be sized using the Dupuit-Forcheimer simplified solution. A second network of very shallow underdrains A second network of very shallow undertrains may be necessary to control surface infiltration perched above near-surface caliche or low-permeability clay soils. In the absence of near-surface caliche soil layers, the deep underdrains should be sized for both the subsurface influx and the net infiltration from the surface. (See also W91-10018) (Korn-PTT) W91-10034

EVALUATION OF GROUNDWATER FLOW CONDITIONS IN THE SAN GABRIEL BASIN, CALIFORNIA, USING A THREE DIMENSION-AL NUMERICAL MODEL.

CH2M Hill, Santa Ana, CA. M. J. Bitner, and T. L. Foreman. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p D8-D18. 8 fig,

3 tab, 8 ref. U. S. Environm Agency Contract No. 68-01-6692. tal Protection

Descriptors: \*Data interpretation, \*Groundwater movement, \*Groundwater pollution, \*Hydrologic models, \*Mathematical models, \*Path of pollutants, \*San Gabriel Basin, California, Flow models, Flow velocity, Geohydrology, Groundwater, Hy-draulic conductivity, Model studies, Porosity, Sen-sitivity analysis, Specific yield, Superfund, Yield.

The San Gabriel Basin is a 170-square mile alluvial groundwater basin, located to the east of Los Angeles, California. Groundwater in the Basin has been contaminated with halogenated organic compounds and areas of the Basin have been listed on the National Priorities List to be addressed under the Superfund program. Numerical groundwater the Superfund program. Numerical groundwater flow models have been developed to aid in understanding groundwater flow patterns in the basin. Two-dimensional vertical slice models of the basin indicate the potential for deep circulation of groundwater, which suggests that deep circulation of the contaminants is possible. Three-dimensional model simulations indicate that regional groundwater flow velocities may range from 100 feet per very rear to over 1,000 feet per very rear to every 1,000 feet per very rear result of the water flow velocities may range from 100 feet per year to over 1,000 feet per year as a result of the variability in the hydrogeologic properties of the basin sediments. Model sensitivity analysis indicates that groundwater flow velocity estimates are most sensitive to estimates of specific yield, effective porosity, and the vertical distribution of hydraulic conductivity. The results of the model simulations are being used to assess contaminant transport and to aid in planning further investigations of the basin. (See also W91-10018) (Author's abstract) W91-10035

INTERFERENCE OF KANATS AND WELLS. Colorado State Univ., Fort Collins. Dept. of Civil Engineering. For primary bibliographic entry see Field 4B.

HYDROGEOLOGIC ANALYSIS OF UNION CARBIDE'S A-19 PIT, EAST GAS HILLS, WYO-

Idaho Univ., Moscow. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 4C.

CHERNOBYL ACCIDENT RAISES A CONCERN REGARDING THE PROTECTION OF GROUND WATER.

Leighton and Associates, Inc., Irvine, CA For primary bibliographic entry see Field 5B. W91-10044

CVBEM ANALYSIS IN SUBSURFACE HYDRAULICS.

Williamson and Schmid, Irvine, CA. For primary bibliographic entry see Field 7C. W91-10046

FEASIBILITY OF ARTIFICIAL RECHARGE TO THE OAKES AQUIFER, SOUTHEASTERN NORTH DAKOTA: HYDROGEOLOGY OF THE OAKES AQUIFER.

North Dakota State Water Commission, Bismarck. For primary bibliographic entry see Field 4B. W91-10063

GEOHYDROLOGY OF THE SURFICIAL AQ-UIFER IN THE HORNELL AREA, IN STEU-BEN AND ALLEGHENY COUNTIES, NEW

T. S. Miller, C. C. Warren, and W. S. McPherson. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. Water-Resources Investigations Report 89-4053, 1990. 7p, 1 ref.

Descriptors: \*Aquifers, \*Geohydrology, \*Ground-water data, \*Hydrologic data collections, \*New York, \*Surficial geology, \*Water resources data, Alluvium, Glacial aquifers, Groundwater budget, Land use, Permeability, Potentiometry, Sand, Saturation, Silt, Soil water, Well yield, Wells.

The aquifer in the Hornell area, in Steuben and Allegheny Counties, New York, consists of stratified glacial drift and subordinate amounts of recent alluvium that partly fill the upper parts of the Canisteo River and Canacadea Creek valleys, which were cut by preglacial streams and subsewhich were cut by preglacial streams and subsequently eroded deeper and wider by glaciers. The aquifer typically consists of 20 to 40 ft of saturated sand and gravel of glaciofluvial origin and subordinate amounts of alluvium. In most areas, the aquifer is underlain by a glaciolacustrine unit of fine sand and silt that is typically more than 150 ft thick. Groundwater in the aquifer generally is unconfined except in low lying areas, where it is overlain by floodplain deposits of fine sand and silt. In some areas, saturated sand and gravel deposits are buried beneath the glaciolacustrine confining unit. Neither the distribution of the buried deposits nor their hydraulic connection with the surficial nor their hydraulic connection with the surficial aquifer could be determined because data were insufficient. Farms, villages, cities, and industry insufficient. Farms, villages, cities, and industry have developed over the aquifer because the area is level, is suitable for building and farming, and generally provides an ample groundwater supply. Because the material overlying the aquifer is permeable, development makes the aquifer susceptible to contamination from sources such as road deicing to contamination from sources such as road decing salt, septic tank leachate, sludge and waste from industrial and commercial facilities, petroleum products leaking from storage tanks, and agricultural chemicals. This report presents the geohydrology of the glacial and alluvial aquifers in the Hornell area. It includes maps at a scale of 1:24,000 that depict locations of wells and test holes (sheet 1), surficial geology (sheet 2), potentiometric surface (sheet 3), saturated thickness (sheet 4), generalized soil permeability (sheet 5). Just use (sheet 6). alized soil permeability (sheet 5), land use (sheet 6), and estimated well yields (sheet 7). (Lantz-PTT)

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PARTS OF AROOSTOOK AND PENOBSCOT COUN-TIES, MAINE.

Maine Geological Survey, Augusta. T. K. Weddle, and C. D. Neil.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report No. 89-1b, 1989. Plate 1 of 6. Map 75. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Penobscot County, Well vield.

This map shows areas, in transect 75 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedcation based on more detailed investigations. Bed-rock wells shown on this map indicate only the depth to bedrock. The map indicates areas where: (1) the approximate boundary of surficial deposits with significant saturated thickness where potential groundwater yield is moderate to excellent; (2) surficial deposits with moderate to good potential groundwater yield--yields generally > 10 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas--yields may exceed 50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield-yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in argential cons alluvium in areas--yield zones are based on subsur-face data where available, and may vary from mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See W91-10070 thru W91-10074) (Lantz-PTT) W91-10069

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PART OF AROOSTOOK COUNTY, MAINE.

Maine Geological Survey, Augusta. T. K. Weddle, and C. D. Neil.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report No. 89-1c, 1989. Plate 2 of 6. Map 76. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Well yield.

This map shows areas, in transect 76 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedrock wells shown on this map indicate only the depth to bedrock. The map indicates areas where:
(1) the approximate boundary of surficial deposits with significant saturated thickness where potential with significant saturated trickness where potential groundwater yield is moderate to excellent; (2) surficial deposits with moderate to good potential groundwater yield—yields generally > 10 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yields may exceed 50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield-yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of gla-cial sand and gravel, but can include sandy till and alluvium in areas--yield zones are based on subsurface data where available, and may vary from mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See W91-10069 and W91-10071 thru W91-10074) (Lantz-PTT)

## Groundwater—Group 2F

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PARTS OF AROOSTOOK COUNTY, MAINE.

Maine Geological Survey, Augusta.

T. K. Weddle, and C. D. Neil.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225.
USGS Open File Report No. 89-1d, 1989. Plate 1 of 6. Map 77. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Well yield.

County, Groundwater budget, Well yield.

This map shows areas, in transect 77 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedrock wells shown on this map indicate only the depth to bedrock. The map indicates areas where: (1) the approximate boundary of surficial deposits with significant saturated thickness where potential groundwater yield is moderate to good potential groundwater yield-yields generally > 10 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas-yields may exceed 50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield-yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas-yield zones are based on subsurface data where available, and may vary from mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See 6991-10069, W91-10070 and W91-10072 thru W91-10071) w91-10071

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PARTS OF AROOSTOOK COUNTY, MAINE.

Maine Geological Survey, Augusta.
T. K. Weddle, and C. D. Neil.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225.
USGS Open File Report No. 89-1e, 1989. Plate 1 of 6. Map 78. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Well yield.

County, Groundwater budget, Well yield.

This map shows areas, in transect 78 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedrock wells shown on this map indicate only the depth to bedrock. The map indicates areas where: (1) the approximate boundary of surficial deposits with significant saturated thickness where potential groundwater yield is moderate to excellent; (2) surficial deposits with moderate to good potential groundwater yield—yields generally > 10 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yields may exceed 50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield—yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yield sons primarily of glacial sand in gravel, but can include sandy till and alluvium in areas—yield zones are based on subsurface data where available, and may vary from

mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See also W91-10079 thru W91-10071 and W91-10073, W91-10074) (Lantz-PTT)

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PARTS OF AROOSTOOK COUNTY, MAINE.

Maine Geological Survey, Augusta. T. K. Weddle, and C. D. Neil. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report No. 89-1f, 1989. Plate 1 of 6. Map 84. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Well yield.

This map shows areas, in transect 84 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedrock wells shown on this map indicate only the depth to bedrock. The map indicates areas where: (1) the approximate boundary of surficial deposits with significant saturated thickness where potential groundwater yield is moderate to excellent; (2) surficial deposits with moderate to good potential groundwater yield—yields generally > 10 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yields may exceed 50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield—yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yield zones are based on subsurface data where available, and may vary from mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See W91-10079 thru W91-10072, and W91-10074) (Lantz-PTT)

HYDROGEOLOGIC DATA FOR SIGNIFICANT SAND AND GRAVEL AQUIFERS, IN PARTS OF AROOSTOOK COUNTY, MAINE.

OF AROOSIOUR COUNTY, MAINE.
Maine Geological Survey, Augusta.
T. K. Weddle, and C. D. Neil.
Available from Books and Open Files Reports
Section, USGS Box 25425, Denver, CO 80225.
USGS Open File Report No. 89-1g, 1989. Plate 1
of 6. Map 85. 1p.

Descriptors: \*Geohydrology, \*Gravel aquifers, \*Groundwater resources, \*Hydrologic data collections, \*Maine, \*Maps, \*Sand aquifers, Aroostook County, Groundwater budget, Well yield.

This map shows areas, in transect 85 of the State of Maine, that are favorable for the development of groundwater supplies from sand and gravel deposits. It is based on field geohydrologic study and on analysis of well, spring, test boring, test pit, and seismic data. The aquifer boundaries and yield designations are generalized and subject to modification based on more detailed investigations. Bedrock wells shown on this map indicate only the depth to bedrock. The map indicates areas where: (1) the approximate boundary of surficial deposits with significant saturated thickness where potential groundwater yield is moderate to excellent; (2) surficial deposits with moderate to good potential groundwater yield—yields generally > 10 gpm to a properly constructed well. Deposits consist prinarily of glacial sand and gravel, but can include sandy till and alluvium in areas—yields may exceed

50 gpm in deposits hydraulically connected with surface water bodies, or inextensive deposits where subsurface data is unavailable; (3) surficial deposits with good to excellent potential groundwater yield-yields generally > 50 gpm to a properly constructed well. Deposits consist primarily of glacial sand and gravel, but can include sandy till and alluvium in areas-yield zones are based on subsurface data where available, and may vary from mapped extent in areas where data is unavailable; (4) surficial deposits with less favorable aquifer characteristics (< 10 gpm); (5) geologic and well information; and (6) seismic line information. (See W91-10069 thru W91-10073) (Lantz-PTT)

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES FOR ISO-LATION OF HIGH-LEVEL RADIOACTIVE WASTE--CHARACTERIZATION OF THE SON-ORAN REGION. ARIZONA.

LATION OF HIGH-LEVEL RADIOACTIVE WASTE-CHARACTERIZATION OF THE SON-ORAN REGION, ARIZONA.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Professional Paper 1370-D, 1990. 40p, 12 fig, 3 tab, 89 ref, 6 plates. Edited by M.S. Bedinger, K.A. Sargent, and William H. Langer.

Descriptors: \*Arizona, \*Geohydrology, \*Groundwater resources, \*Radioactive waste disposal, \*Radioactive wastes, \*Sonoran Desert, Arid lands, Groundwater discharge, Groundwater movement, Groundwater recharge, Rocks, Surface drainage, Waste disposal.

The Sonoran region, southwestern Arizona, of the Basin and Range province, is south and east of the Colorado River. Basins of the region generally trend north-northwest. Surface drainage is to the Colorado River, major tributaries being the Bill Williams and Gila Rivers. A few basins have interior or poorly integrated drainage, Potential host media for isolation of high-level radioactive waste in the Sonoran region, Arizona, include intrusive rocks, tuffaceous rocks, basaltic rocks, laharic breccias, and salt. Basin-fill deposits, and possibly other rock types, have potential as host media in the unsaturated zone. The Sonoran region is arid with annual precipitation < 200 mm throughout most of the region and annual potential evaporation > 2.5 m. Recharge of groundwater occurs principally in areas of higher altitude where bedrock is permeable and by infiltration of mountain runoff in the basin areas. Discharge of groundwater occurs by seepage to gaining streams, by evapotranspiration, by withdrawal from wells, and from springs. In most of the region, the concentration of dissolved solids in groundwater is < 500 mg/L. Groundwater near the Gila River and the Colorado River, however, contains 1,000 mg/L or more dissolved solids. The groundwater is mostly of the calcium magnesium or sodium bicarbonate type. Sulfate and chloride type waters occur in and near large discharge areas and in some playas. (Lantz-PTT)

REMOTE SENSING APPLIED TO HYDRO-GEOLOGY THROUGH CASE STUDIES. For primary bibliographic entry see Field 7B. W91-10091

SATELLITE HYDROGEOLOGY. For primary bibliographic entry see Field 7B. W91-10092

ELECTRO-HYDROLOGICAL ANALOGIES, Polish Academy of Sciences, Warsaw. Inst. of Geophysics. For primary bibliographic entry see Field 2E. W91-10110

GROUNDWATER RESOURCES IN EGYPT: POTENTIALS AND LIMITATIONS. International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).

## **Group 2F—Groundwater**

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 179-192, 9 fig, 2 tab, 20 ref.

Descriptors: \*Arid-zone hydrology, \*Egypt, \*Groundwater management, \*Groundwater poten-tial, \*Groundwater resources, \*Limiting factors, Arid lands, Deserts, Groundwater, Groundwater recharge, Groundwater use, Pumping, Saline water intrusion, Selective withdrawal.

The Egyptians, during the course of centuries, have undertaken the exploitation of groundwater to varying extents. Other than the Eastern Desert to varying extents. Other man the Eastern Desert and Sinai there are five contributing zones: coastal plain in the Western Desert (zone 1), cases in the Western Desert (zone 2), country between Cairo and the Suez Canal east of the Nile Delta (zone 3), and the Suez Canal east of the Nile Delta (zone 3), the Nile Delta area (zone 4), and the Valley in Upper Egypt (zone 5). The groundwater in zone 1 is renewed by rain water, in zone 2 it is fossil, and in zone 3 it is replenished by seepage water. Zones 4 and 5 are replenished through over-irrigation and seepage from canals. The estimated extractions from the five zones are, respectively, 0.25, 2.0, 0.5, 3.0, and 1.25 cu m/year. These extractions will cause a lowering of the piezometric head. This might improve the drainage of the clay cap covering zones 4 and 5. Instead of flowing freely, groundwater has to be pumped from the deep wells in the oases. This is going to affect the economy of the project aimed at expanding the agriculture there. Salt water may intrude further inland in the Delta area as a result of continuous inland in the Delta area as a result of continuous pumping. Since the freshwater layer overlying the saline water body in the western coastal strip is thin, care should be exercised while locating the depth at which extraction of groundwater takes place as well as the rate of extraction. (See also place as well as the rat W91-10103) (Fish-PTT)

KARST HYDROLOGY AND WATER RE-SOURCES-PAST, PRESENT, AND FUTURE. Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences

O. Bonacci. O. Bonacci. In: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 205-213, 3 fig. 11 ref.

Descriptors: \*Groundwater management, \*Groundwater resources, \*Karst hydrology, \*Surface-groundwater relations, \*Water resources management, \*Yugoslavia, Aquifer management, Drainage engineering, Flood control, Geochemistry, Groundwater storage, Hydrologic models, Hydrologic systems Kerst Hydrologic systems, Karst.

The karst represents a specific area consisting of surface relief and a surface and underground netsurface relief and a surface and underground net-work of channels and pathways resulting from the circulation of water and its aggressive chemical and physical action on soluble rocks, such as lime-stone, gypsum, chalk, salt, and sometimes dolo-mites. Owing to specific geological, geomorpholo-gical, and particularly hydraulic characteristics, karst areas exhibit specific water circulation pat-terns which should be studied by appropriate methods. The karst areas of Yugoslavia represent the cradle of the systematic study of the karst of methods. The karst areas of Yugoslavia represent the cradle of the systematic study of the karst of the world. While solutions in the past were mainly based upon experience, present and future solutions imply more detailed interdisciplinary approaches. The study of the hydrology of karst poljes in Yugoslavia as well as the method of their drainage in the proportions of the representation of the study of the hydrology of the study in the second of the study rugosavia as weil as the method of their drainage is very important, as these represent the only suitable living conditions within the karst. These areas are almost regularly flooded in the cold and wet periods from October to April. Steps have been taken to improve the hydrological regimes of these areas and more efforts will be directed to this effort in the future. Man's influence on changes of the water regime in poljes can be divided into four categories: water storage, increase in the capacity of the outlet structures, surface hydrotechnical works, and pumping of groundwater. Current methods of investigation and measurement in the karst which can be carried out to gather the necessary data to plan further activities include: piezo-

metric data; various tracers; speleological investigations; remote sensing; geophysical methods; measurements of chemical composition; water temperature measurements; hydrological and hydrometric measurements; and observation of flora, fauna, and microorganisms. In the near future, the application of complex physical hydrological models to outflow analyses in karst catchment areas will be routine. (See also W91-10103) (Fish-W91-10123

SORPTION STUDIES OF VOCS RELATED TO SOIL/GROUND WATER CONTAMINATION AT LLNI

Lawrence Livermore National Lab., CA For primary bibliographic entry see Field 5B. W91-10235

LEACHING OF METAL POLLUTANTS FROM FOUR WELL CASINGS USED FOR GROUND-WATER MONITORING.

Cold Regions Research and Engineering Lab., Hanover, NH. For primary bibliographic entry see Field 7B. W91-10236

PROCEDURES FOR GROUND-WATER INVES-

TIGATIONS.
Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 7A. W91-10243

INFLUENCE OF WELL CASING COMPOSITION ON TRACE METALS IN GROUND WATER.

Cold Regions Research and Engineering Lab., Hanover, NH. For primary bibliographic entry see Field 7B. W91-10247

GROUND-WATER RESOURCES AND SIMU-LATED EFFECTS OF WITHDRAWALS IN THE SHORE AREA OF GREAT SALT LAKE, UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div.

W. Clark, C. L. Appel, P. M. Lambert, and R.

L. Puryear: Available from the Utah Department of Natural Resources, Division of Water Rights, 1636 West North Temple, Room 220, Salt Lake City, UT 84116. Technical Publication No. 93, 1990. 150p, 67 fig, 13 tab, 43 ref, 1 plate.

Descriptors: \*Great Salt Lake, \*Groundwater resources, \*Mathematical models, \*Simulation analysis, \*Surface-groundwater relations, \*Water table decline, Groundwater discharge, Groundwater level, Groundwater mining, Groundwater relevel, Groundwater mining, Groundwater re-charge, Hydrologic models, Model studies, Utah,

The East Shore aquifer system of Great Salt Lake is in basin-fill deposits, and is primarily a confined system with unconfined parts near the mountain front. Recharge to and discharge from the East Shore aquifer system were estimated to average about 160,000 acre-ft/yr during 1969-84, with minor amounts of water being removed from storage during that period. Major sources of groundwater recharge are seepage from surface water in natural channels and irrigation canals, and subsur-face inflow from consolidated rock to the basin-fill face inflow from consolidated rock to the basin-till deposits. Discharge of groundwater is primarily to wells, water courses, springs, and as diffuse seepage to Great Salt Lake. Average annual surface water inflow to the study area was estimated to be 860,000 acre-ft for the period 1969-84. Annual withdrawal of groundwater for municipal and injustrial use increased from about 10,000 acre-ft in dustrial use increased from about 10,000 acre-ft in 1960 to more than 30,000 acre-ft in 1980 to supply a population that increased from 175,000 in 1960 to 290,000 in 1980. Long-term trends of groundwater levels indicate a steady decline at most observation wells since 1952, despite near normal or increased precipitation since the late 1960's. Water levels declined as much as 50 ft near the principal pump-

ing center in the east-central part of the study area A numerical model of the East Shore aquifer system in the Weber Delta area was constructed and calibrated using water level data and changes in groundwater withdrawals for 1955-85. Prediction in groundwater withdrawals for 1955-85. Predictive simulations were made based on doubling the 1980-84 rate of municipal and industrial withdrawals for 20 years, and using both average and below average recharge rates. The simulations indicated water level declines of an additional 35-50 ft near the principal purpose content decrease in partial the principal pumping center; a decrease in natural discharge to drains, evapotranspiration, and Great Salt Lake; and a decrease in groundwater storage of 80,000 to 115,000 acre-ft after 20 years. (Author's abstract) W91-10262

REGIONAL GROUND-WATER QUALITY CHARACTERIZATION OF THE ROCKFORD AREA, WINNEBAGO COUNTY, ILLINOIS.

Illinois State Water Survey Div., Champaign. Ground-Water Section. For primary bibliographic entry see Field 5G. W91-10265

STATUS AND TRENDS OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE SAN ANTONIO REGION.

Southwest Texas State Univ., San Marcos. For primary bibliographic entry see Field 6D. W91-10446

### 2G. Water In Soils

INFLUENCE OF FERTILIZER, IRRIGATION, AND NON-GROWING SEASON PRECIPITA-TION ON SOIL NITRATE-NITROGEN UNDER CORN.
Macdonald Coll., Ste. Anne de Bellevue (Quebec).

Dept. of Renewable Resources. For primary bibliographic entry see Field 3F. W91-09342

PESTICIDE AND NUTRIENT MOVEMENT INTO SUBSURFACE TILE DRAINS ON A SILT

INIO SUBSURFACE IILE BRAINS ON A SILI LOAM SOIL IN INDIANA. Purdue Univ., Lafayette, IN. Dept. of Agronomy. For primary bibliographic entry see Field 5B. W91-09356

MEASUREMENT AND CHARACTERIZATION OF MACROPORES BY USING AUTOCAD AND AUTOMATIC IMAGE ANALYSIS.

Lowa State Univ., Ames. Dept. of Agricultural

Engineering.
P. Singh, R. S. Kanwar, and M. L. Thompson.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 289-294, January/March 1991. 7 fig. 1 tab, 32 ref. Iowa Agric. and Home Econ. Exp. Stn. Project No. 2792.

Descriptors: \*Computer-aided design, \*Macro-pores, \*Path of pollutants, \*Pore size, AUTO-CAD, Analytical methods, Computer models, Data acquisition, Data interpretation, Leaching, Soil analysis, Soil porosity, Soil water, Tillage.

Preferential transport of chemicals may contribute greatly to groundwater contamination because some of the nutrients and chemicals applied on the some of the nutrients and chemicals applied on the soil surface move through macropores instead of moving through the soil matrix where they could be adsorbed, chemically degraded or biologically transformed. Macropores (with diameters greater than 1600 microns) were quantified under no till and conventional tillage practices by using AUTO-CAD and automatic image analysis. To quantify macropores, undisturbed soil blocks (50 by 50 cm) were imprepniated with plaster of paris slurry. were impregnated with plaster of paris slurry.

After the plaster of paris set, soil layers were taken out in 5 cm increments to a total depth of 60 cm. At each soil plane pictures were taken by a 35 mm camera and macropores were traced on transparent scheets were sheets. The pictures and transparent sheets were analyzed by using an automated image analyzer and AUTOCAD, respectively, for total number, perimeter area, and size frequency distri-

## Water In Soils—Group 2G

bution of macropores. The AUTOCAD method proved to be simpler and better than the image analysis technique. Larger and continuous cracks accounted for greater macropore area in conventional tillage sites than in no till sites. However, more worm holes and root holes accounted for a greater number and larger perimeters of macropores in no-till sites in comparison to conventional tillage sites. (See also W91-09359) (Author's abstract)

## PREFERENTIAL SOLUTE TRANSPORT THROUGH MACROPORES IN LARGE UNDIS-TURBED SATURATED SOIL COLUMNS.

Iowa State Univ., Ames. Dept. of Agricultural

P. Singh, and R. S. Kanwar.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 295-300, January/March 1991. 6 fig. 2 tab, 43 ref. Iowa Agricultural and Home Economics Exp. Stn. Project No. 2792.

Descriptors: \*Path of pollutants, \*Pores, \*Soil col-umns, \*Solute transport, Flow profiles, Hydraulic conductivity, Interstitial water, Leaching, Pore size, Soil porosity, Soil water, Tillage.

Six large undisturbed soil columns (61 cm in length, 15 cm in diameter) were collected from three no-till and three conventional tillage plots. The sidewalls of these columns were sealed with either plaster of paris or paraffin wax to eliminate wall effects. After these columns were saturated with CaSO4 (0.005 M), CaCl (0.005 M) was applied at the surface and the effluent was collected at the bottom. Effluent samples were later analyzed for Cl (chloride) concentrations. The Cl lyzed for Cl (chloride) concentrations. The Cl breakthrough curves (relative Cl concentration vs. relative pore volume) were developed and the degree of preferential flow analyzed. Shape and degree of preferential flow analyzed. Shape and other breakthrough curve parameters, such as immobile pore water fraction and initial breakthrough, indicated the occurrence of preferential flow through all columns. The degree of preferential flow, however, was greater in no-till than in conventional tillage columns (average immobile pore-water fraction was 56% for no till and 49% for conventional tillage columns). Because lab studies using undisturbed soil columns do not include the effect of large continuous soil cracks, field studies are needed to monitor the solute transfield studies are needed to monitor the solute transfield studies are needed to monitor the solute trans port processes caused by cracks. (See also W91-090358) (Author's abstract) W91-09359

## FACTORS INFLUENCING THE SOIL SALINI-TY REGIME ALONG AN INTERTIDAL GRA-DIENT.

Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).

For primary bibliographic entry see Field 2L. W91-09372

### DITCH DRAINAGE IN LAYERED SOILS.

Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Irrigation and Drainage Engineering. For primary bibliographic entry see Field 4A. W91-09393

## COSOLVENT EFFECTS ON SORPTION AND MOBILITY OF ORGANIC CONTAMINANTS IN SOILS.

Robert S. Kerr Environmental Research Lab., Ada, OK.

For primary bibliographic entry see Field 5B. W91-09430

## EFFECT OF SUBSTITUTED BENZOPHENONES ON THE PHOTOCHEMICAL FATE OF FENITROTHION INSECTICIDE.

International Atomic Energy Agency, Seibersdorf (Austria). Labs.

For primary bibliographic entry see Field 5B. W91-09431

INFILTRATION AND EVAPOTRANSPIRA-TION WITHIN THE ALBUQUERQUE, NEW MEXICO, AREA WITH A SECTION ON HIS-TORICAL WATER-RESOURCE TRENDS DURING THE 1954-80'S PERIOD OF URBAN GROWTH.

Geological Survey, Albuquerque, NM. Water Resources Div. For primary bibliographic entry see Field 2D. W91-09551

## RELEASE OF 2,4-DICHLOROBENZOIC ACID FROM SILICONE TUBING.

Aarhus Univ. (Denmark). Inst. of Geology. For primary bibliographic entry see Field 7B. W91-09663

## DISTRIBUTION OF SIX HEAVY METALS IN CONTAMINATED CLAY SOILS BEFORE AND AFTER EXTRACTIVE CLEANING.

Technische Hogeschool Eindhoven (Netherlands). Dept. of Chemical Technology. For primary bibliographic entry see Field 5G. W91-09670

# REMOVING HEAVY METALS FROM CON-TAMINATED CLAY SOILS BY EXTRACTION WITH HYDROCHLORIC ACID, EDTA OR HY-POCHLORITE SOLUTIONS.

Technische Univ. Eindhoven (Netherlands). Dept. of Electrical Engineering.
For primary bibliographic entry see Field 5G.
W91-09678

# SOIL CLEAN UP IN-SITU AERATION. II. EF-FECTS OF IMPERMEABLE CAPS, SOIL PER-MEABILITY, AND EVAPORATIVE COOLING. Vanderbit Univ., Nashville, TN. Dept. of Chemis-

For primary bibliographic entry see Field 5G. W91-09683

# SOIL CLEAN UP BY IN-SITU SURFACTANT FLUSHING, II. THEORY OF MICELLAR SO-LUBILIZATION. Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

For primary bibliographic entry see Field 5G. W91-09685

## SOIL CLEAN UP BY IN-SITU AERATION, III. PASSIVE VENT WELLS, RECONTAMINA-TION. AND REMOVAL OF UNDERLYING NONAQUEOUS PHASE LIQUID. Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

For primary bibliographic entry see Field 5G. W91-09686

SOIL LOOSENING AND DRAINAGE OF STRUCTURALLY UNSTABLE SILTY SOILS. Department of Agriculture, Seale-Hayne Faculty of Agriculture, Food and Land Use, Polytechnic South West, Newton Abbot, Devon TQ12 6NQ, England

S. J. Twomlow, R. J. Parkinson, and I. Reid. Journal of Hydrology JHYDA7, Vol. 121, p 63-83, December 1990. 7 fig, 3 tab, 62 ref.

Descriptors: \*Agricultural runoff, \*Drainage practices, \*Drainage systems, \*Soil properties, \*Soil water, \*Subsurface drainage, Seasonal variation, Soil types Stormers. Soil types. Storm runoff.

The successful control of both ground and surface water problems depends on the selection of a drainage treatment that is most appropriate to each situation. Secondary drainage treatments are car-ried out with the objective of enhancing the per-formance of permanent piped schemes. A drainage experiment was designed to investigate the effect of soil loosening on storm water redistribution in a structurally unstable silt soil following the installation of underdrainage. Results show that even though loosening reduced dry bulk density between 0.2 and 0.4 m depth by 15%, with a 270%

increase in transmission pores (>60 micrometer equivalent diameter) at the interface of what was the cultivated and undisturbed soil, drainage efficiency was not enhanced, as might have been expected from the 10 to 20-fold increase in hydraulic conductivity. Loosening not only lengthens the median time of concentration by 0.42 and 0.33 h for simple and secondary winter storms, respec-tively, but also caused lower peak discharges when compared with unloosened soil. Measurements of soil water energetics reveal that a greater propor-tion of rainfall is diverted into the loosened zone tion of rainfall is diverted into the loosened zone below the plough layer and detained there, reduc-ing the 24 h drainage efficiency. On a seasonal timescale, the greater storage between 0.2 and 0.4 m depth causes a 6.3% increase in the winter mean m depin causes a 0.3% increase in the winer mean water content, and means that the rooting environ-ment of the loosened soil is wetter prior to a rainstorm. Consequently, in wet autumns and springs, loosened soils will be more susceptible to structural damage by animal poaching or the traf-fic of farm machinery. (Author's abstract) W91-09712

## CONTAMINATION OF SOIL AND GROUND-WATER BY AUTOMATIC TRANSMISSION FLUID: SITE DESCRIPTION AND PROBLEM ASSESSMENT.

General Motors Research Labs., Warren, MI. En-

vironmental Science Dept. For primary bibliographic entry see Field 5B. W91-09716

## SEASONAL VARIATION OF CLOGGING OF AN ARTIFICIAL RECHARGE BASIN IN A NORTHERN CLIMATE.

North Dakota State Water Commission, Bismarck. For primary bibliographic entry see Field 4A. W91-09719

#### INVERSE METHOD FOR ESTIMATING SOIL CORE WATER CHARACTERISTICS.

Institut National de la Recherche Agronomique de Tunisie, Tunis.

For primary bibliographic entry see Field 7B. W91-09731

# RELATION BETWEEN INFILTRATION AND STONE COVER ON A SEMIARID HILLS-LOPE, SOUTHERN ARIZONA. State Univ. of New York at Buffalo. Dept. of

Geography. For primary bibliographic entry see Field 2E. W91-09735

## TEMPERATURE DEPENDENCE OF PONDED INFILTRATION UNDER ISOTHERMAL CON-

Geological Survey, Menlo Park, CA. J. Constantz, and F. Murphy. Journal of Hydrology JHYDA7, Vol. 122, p 119-128, January 1991. 5 fig. 2 tab, 26 ref.

Descriptors: \*Infiltration, \*Isotherms, \*Mathematical studies, \*Soil water, \*Temperature effects, Hydraulic conductivity, Model studies, Physical properties, Saturation, Soil types, Transmissivity, Viscosity, Wetting.

A simple temperature-sensitive modification to the Green and Ampt infiltration equation is described; this assumes that the temperature dependence of the hydraulic conductivity is reciprocally equal to the temperature dependence of the viscosity of liquid water, and that both the transmission zone saturation and the wetting front matrix potential saturation and the wetting front matrix potential gradient are independent of temperature. This modified Green and Ampt equation is compared with ponded, isothermal infiltration experiments run on repacked columns of Olympic Sand and Aiken Loam at 5, 25, and 60 C. Experimental results showed increases in infiltration rates of at least 300% between 5 and 60 C for both soil least 300% between 3 and 60 C for ooth sommaterials, with subsequent increases in cumulative infiltration of even greater magnitudes for the loam. There is good agreement between measured and predicted initial infiltration rates at 25 C for

## Group 2G-Water In Soils

both soil materials, yet at 60 C, the predicted results overestimate initial infiltration rates for the sand and underestimate initial rates for the loam. Measurements of the wetting depth vs. cumulative infiltration indicate that the transmission zone satuinfiltration indicate that the transmission zone saturation increased with increasing temperature for both soil materials. In spite of this increased saturation with temperature, the final infiltration rates at both 25 and 60 C were predicted accurately using the modified Green and Ampt equation. This suggests that increased saturation occurred primarily in dead-end pore spaces, so that transmission zone hydraulic conductivities were unaffected by these temperature-induced changes in saturation. Except for initial infiltration rates at 60 C, the measured influence of temperature on infiltration rates was influence of temperature on infiltration rates was fully accounted for by the temperature dependence of the viscosity of liquid water. (Author's abstract)

SURFACE RUNOFF AND SOIL WATER PER-COLATION AS AFFECTED BY SNOW AND

Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences. For primary bibliographic entry see Field 2C. W91-09741

INFLUENCE OF MACROPORES ON RUNOFF GENERATION FROM A HILLSLOPE SOIL
WITH A CONTRASTING TEXTURAL CLASS.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of

For primary bibliographic entry see Field 2E. W91-09744

ANALYSIS OF FLOW INTO DRAINTILE IN THREE-DIMENSIONAL FLOW FIELD, Lakehead Univ., Thunder Bay (Ontario). Dept. of

Lakeneau Chiv., Hindier Ind. (Civil Engineering. G. Hazebberg, and U. S. Panu. Journal of Hydrology JHYDA7, Vol. 122, p 321-333, January 1991. 1 fig, 1 tab, 7 ref, append.

Descriptors: \*Drainage systems, \*Mathematical studies, \*Soil water, \*Tile drains, Flow rates, Saturation, Soil types, Subsurface water.

Draintiles (impervious lengths of pipe laid end to end with gaps between adjacent sections to permit water entry) are commonly used in the drainage of agricultural lands and airport runways, and are employed to ensure the foundational stability of employed to ensure the foundational stability of many structures. The rate of flow into a line of draintiles buried in water-saturated soil depends upon the width and spacing of the gaps between the tiles as well as other parameters. A formula is developed for the general, non-axisymmetric case to determine the flow rate into a single gap. The differences between the formula developed here and the one developed by Prasad and coworkers are discussed in terms of their derivation. For some cases in which the potential on the outer boundary of the solution zone does not vary longitudinally, the two solutions provide the same results; in other cases, the differences are significant. However, with perforated draintubes preferred over the draintiles in recent years, there is a need to extend the solutions presented to the perforated drain-tubes. (Agostine-PTT) W91-09750

NUMERICAL SIMULATION OF INFILTRA-TION AND SOLUTE TRANSPORT IN AN S-SHAPED MODEL BASIN BY A BOUNDARY-FITTED GRID SYSTEM.

Tokyo Inst. of Tech. (Japan). Dept. of Civil Engi-

neering. T. Kinouchi, M. Kanda, and M. Hino. Journal of Hydrology JHYDA7, Vol. 122, p 373-406, January 1991. 19 fig, 2 tab, 54 ref.

Descriptors: \*Infiltration, \*Model studies, \*Non-point pollution sources, \*Rainfall-runoff relation-ships, \*Simulation analysis, \*Soil water, \*Soilute transport, Aeration zone, Boundary conditions, Experimental basins, Flow velocity, Hydrographs, Mathematical studies, Overland flow, Precipita-tion Punoff tion, Runoff.

The boundary-fitted grid method, which transforms a complicated computational domain into a rectangular domain, is applied for the moisture and solute transport problems in the unsaturated soil layer of an S-shaped model hillslope. In the trans-formed domain, the fundamental equations of mois-ture and solute transport (i.e. the Richards equation and the Fickian equation) can be easily discre-tized into the finite-difference form. This results in computational memory size and CPU time being greatly reduced, making it possible to perform the computation with a personal computer. For three types of rainfall pattern (a unit rainfall, two-unit successive rainfalls and two-unit rainfalls with a lag between them), hydrographs of total (pre-event and event water) and event water discharges, contour lines of soil moisture, pressure and total hy-draulic head distributions, and flow velocity vecor for a relatively light rainfall, the capillary fringe effect plays an important role, whereas for a relatively thin soil layer or for a relatively has soil layer or for a relatively thin soil layer or for a relatively has soil layer or for a relatively heavy rainfall, overland flow from a variable source area. is superimposed on the capillary-fringe-type runoff. A second rainfall after short cessation of the first yields a much higher runoff peak of the event water compared with the first peak. During a short water compared with the inst peak. During a short cessation, soil moisture and solute diffuse in unsatu-rated soil, and the discharge of the first rainfall component may occur by the increased pressure gradient resulting from the second rainfall. (Agostine-PTT)

EFFECT OF TRANSVERSE DISPERSION ON

SOLUTE TRANSPERS DISPERSION ON SOLUTE TRANSPORT IN SOILS.

Auburn Univ., AL. Dept. of Agronomy and Soils.

F. J. Leij, and J. H. Dane.

Journal of Hydrology JHYDA7, Vol. 122, p 407-422, January 1991. 13 fig, 1 tab, 17 ref.

Descriptors: \*Dispersion, \*Nonpoint pollution sources, \*Path of pollutants, \*Soil water, \*Solut transport, Flow pattern, Interstitial water, Mathematical studies, Pore velocity, Soil contamination,

Most theoretical and experimental investigations of solute transport involve one-dimensional problems (i.e. soil column studies), whereas in reality many soil pollution problems concern transport and flow in more than one dimension. Two-dimensional transport was studied with emphasis on the contri-bution of transverse dispersion to solute transport. Three problems were studied with a finite element code. The first problem involved one-dimensional code. The first problem involved one-dimensional flow parallel to the interface of two layers with differing pore water velocity. The early arrival of the solute at the end of the low-permeability layer and the increase in solute spreading for both layers, as a result of transverse dispersion, were demonstrated. The second problem concerned pollution from a bounded surface area (point source) in a two-layer medium. The development of a solute plume during downward flow was shown to depend on transverse dispersion. The third problem studied was transport from an unbounded sur-face area (diffuse source) in a nonuniform flow field to a drainage pipe. Attempts to collect the pollutant depend, among other things, on the value pontuan depend, among other things, on the value of the transverse dispersivity. Thus, the magnitude of the transverse dispersion coefficient influenced the region to which the pollution extended as well as the intensity of the pollution. (Agostine-PTT) W91-09754

SOIL-MOISTURE CONDITIONS AND DISCHARGE FORECASTING (ETAT HYDRIQUE DU SOL ET PREVISION DES DEBITS).

Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique. For primary bibliographic entry see Field 2A. W91-09776

EVALUATING THE GREEN AND AMPT IN-FILTRATION PARAMETER VALUES FOR TILLED AND CRUSTED SOILS. International Inst. of Tropical Agriculture, Ibadan

(Nigeria). Y. M. Mohamoud.

Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 25-38, February 1991. 3 fig, 3 tab, 32 ref.

Descriptors: \*Agricultural hydrology, \*Infiltra-tion, \*Rainfall infiltration, \*Soil water, Hydraulic conductivity, Land management, Rainfall impact, Rainfall-runoff relationships, Soil surfaces, Soil

Predicting and understanding rainfall infiltration on agricultural soils under different management on agreement some once it determines the practices is important for establishing best management practices for a given soil, topography, and rainfall regime. Methods for determining Green-Ampt infiltration parameter values for tilled and Ampt infiltration parameter values for crusted soils are not well-established. A two-stage method has been developed to determine the Green and Ampt parameter values for soils under offeren and Amp parameter values for sols under different management practices. The first stage is aimed at calculating rainfall infiltration from rain-fall and runoff data of small field plots which had different soil surface conditions (e.g. tillage, residurecent soil surface conditions (e.g. tiliage, residue cover, and crusting). To determine accurate rainfall infiltration rates from field plots, a water balance model was employed which accounted for depression storage, detention storage, as well as surface routing of runoff. The second stage is aimed at evaluating the values of the Green and Ampt infiltration equation parameters by the linear least squares parameter estimation technique. The Green and Ampt parameter values determined were the effective capillary suction at the wetting front and the effective hydraulic conductivity. The results of this study indicated that this procedure is sufficiently sensitive to reflect the effects of tillage, residue cover, and crusting on infiltration data. Raindrop impact reduced infiltration rates by crusting the soil surface. However, most of the management systems that left about 30% of residue cover protected the soil from raindrop impact as evidenced by the higher effective hydraulic con-ductivity. The model developed by Green and Ampt in 1911 satisfactorily fitted the infiltration data obtained from protected and crusted soil pro-files. Also, residue cover and crusting greatly influenced the Green and Ampt infiltration parameter values. (Author's abstract) W91-09778

TWO-DIMENSIONAL UNSATURATED FLOW IN IRREGULARLY SHAPED REGIONS USING A FINITE VOLUME METHOD.

National Technical Univ., Athens (Greece). Lab. of Rural Technology.
G. P. Tsakiris, J. V. Soulis, and C. V. Bellos.

Transport in Porous Media TPMEEI, Vol. 6, No. 1, p 1-12, February 1991. 7 fig, 14 ref.

Descriptors: \*Aeration zone, \*Finite element method, \*Flow equations, \*Model studies, \*Un-saturated flow, Hydraulic geometry, Infiltration, Numerical analys

The two-dimensional flow of water in an unsaturated soil profile has been extensively studied using analytical and computational techniques. Due to the emphasis given to methods of localized irrigation, attention has been focused on water applica-tion in soil through various types of sources. To describe the two-dimensional flow of water in unsaturated soil, the governing equation was solved on a mesh constructed from small area elements. A transformation was introduced with which these possibly distorted rectangular elements of the possibly distorted rectangular elements of the physical plane were mapped into computational squares. Thus, irregularly-shaped regions, which present difficulties when attempting to describe their geometry on an orthogonal computational mesh, can be more easily modeled. Using this methodology, called the finite volume method, numerical results were obtained showing the satisfactory ability of the method to describe transient factory ability of the method to describe transient unsaturated flow. However, extensive testing of the method should be carried out before final conclusions can be drawn. (Author's abstract) W91-09793

RICHARDS' ASSUMPTIONS AND HASSLER'S PRESUMPTIONS.

Commonwealth Scientific and Industrial Research

## Water In Soils—Group 2G

Organization, Canberra (Australia). Div. of Envi-For primary bibliographic entry see Field 2F. W91-09794 nental Mechanics

CHARACTERIZATION OF GROUND-WATER FLOW AND CHEMICAL TRANSPORT BE-NEATH TWO IRRIGATED FIELDS IN SOUTH-CENTRAL KANSAS, 1988.

Geological Survey, Lawrence, KS. Water Re-

For primary bibliographic entry see Field 5B. W91-09834

TILLAGE AND IRRIGATION EFFECTS ON ROOT GROWTH, SOIL WATER DEPLETION AND YIELD OF WHEAT FOLLOWING RICE, Punjab Agricultural Univ., Ludhiana (India). Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils. For primary bibliographic entry see Field 3F. W91-09936

## GEOCHEMISTRY OF SOILS OF SPITSBER-

Moscow State-Lenin Pedagogical Institute.

V. V. Dobrovolskiy. Soviet Soil Science SSSCAE, Vol. 22, No. 6, p 1-15, 1990. 5 tab, 18 ref. Translated from Pochvovedeniye, No. 2, 1990.

Descriptors: \*Arctic, \*Heavy metals, \*Norway, \*Permafrost, \*Soil analysis, \*Soil chemistry, \*Soil profiles, \*Spitsbergen, Humic acids, Magnesium, Potassium, Sodium, Temperature.

Spitsbergen (Norway) soils exhibit properties typical of all Arctic islands: a truncated profile of the A-C type, shallow permafrost table, raw peat humus enrichment of the upper part of the profile, and the presence of water-soluble salts in the uppermost horizon. The warm North Atlantic drift accounts for Spitsbergen's less severe temperatures accounts for Spitsbergen's less severe temperatures and larger amounts of precipitation compared to other areas of the Arctic. The morphology, chemical composition, and trace elements of soils of Spitsbergen were analyzed. Raw humus (peat) accumulation with weakly condensed humic acids was typical for all soil types. The concentration of mobile forms of heavy metals (water and IN HCL extraction) increased in the upper horizon of the profile and in its lower part above the surface of extraction) increased in the upper notize of or permafrost. The concentration of strontium and the water-soluble salts of magnesium, sodium, and potassium was highest in the uppermost horizon of the profile. It is believed that heavy metals, stronti-um and lithium uptake by soils in Spitsbergen is based on mass transport of ocean-derived aerosols. (Medina-PTT) (Medina-PTT) W91-09947

INFLUENCE OF SOIL, PLANT AND METEOR-OLOGICAL FACTORS ON WATER RELA-TIONS AND YIELD IN HEVEA BRASILIEN-

Rubber Research Inst. of India, Kerala. For primary bibliographic entry see Field 2I. W91-09953

SPATIAL SCALE DEPENDENCE OF IN SITU SOLUTE TRANSPORT.

Guelph Univ. (Ontario). Dept. of Land Resource

Science.

I. J. Van Wesenbeeck, and R. G. Kachanoski.
Soil Science Society of America Journal SSSJD4,
Vol. 55, No. 1, p 3-7, January/February 1991. 5
fig, 1 tab, 12 ref.

Descriptors: \*Dispersion, \*Path of pollutants, \*Scale factors, \*Soil water, \*Solute transport, \*Unsaturated flow, \*Water chemistry, Breakthrough curves, Chlorides, Forest soils, Soil physics, Tillage, Tracers, Traveltime.

In field solute transport experiments, two spatial scales of the continuum of the dispersion process were measured: local scale and field scale. The objective was to develop a method for measuring in situ the transition from the local scale to the

field scale during unsaturated flow conditions. The spatial variability of in situ solute dispersion was examined in two field sites. Soil solution samplers were installed in a transect at a 0.4-m depth and 0.2-m spacing in both a cultivated and never-cultivated (forested) site. A pulse of KCl was applied to both sites under conditions of constant surface flux density of water, which was applied using a trickle irrigation system. The variance of solute travel time at different spatial scales was calculated from moment analysis of breakthrough curves obtained by averaging local breakthrough curves across different spatial scales. The scale dependence of variance of solute travel time indicated scales of at least 2.8 and 3.8 m were needed to reach an were installed in a transect at a 0.4-m depth and least 2.8 and 3.8 m were needed to reach an effective far field variance for the forested and cultivated sites, respectively. The larger scale in the cultivated site was due to an increase in horizontal correlation length scales of soil properties caused by tillage mixing. The scale dependence of the variance of solute travel time can be used to determine the minimum plot size necessary to in-clude all major horizontal variations in solute travel time, which can then be compared with spatial distributions of soil properties affecting them. (Author's abstract)

W91-09960

ESTIMATION OF WATER-RETENTION FUNCTION USING SCALING THEORY AND SOIL PHYSICAL PROPERTIES. ESTIMATION

SOIL PHYSICAL PROPERTIES.
Reading Univ. (England). Dept. of Soil Science.
C. C. Daamen, Z. Xiao, and J. A. Robinson.
Soil Science Society of America Journal SSSJD4,
Vol. 55, No. 1, p 8-13, January/February 1991. 3
fig, 5 tab, 33 ref. Australian Water Resources Advisory Council (AWRAC) F88-01.

Descriptors: \*Scale factors, \*Scaling theory, \*Soil moisture retention, \*Soil physical properties, \*Soil physics, \*Soil water, Loam, Mathematical models, Model studies, Parameterization, Regression analy-

Estimation or measurement of water retention functions is an important part of studies of water balance in soils. Characterization of a spatially variable water retention function, S(h), where S is the degree of saturation, is demonstrated with a data set from a 2-ha watershed. The soil is classified as Shepparton fine sandy loam. Four common functional forms for S(h) were fitted to the data set using scaling theory and nonlinear regression. Initially, only one model parameter, associated with a scaling factor, was fitted independently to each core. This scaling approach accounts for most of core. This scaling approach accounts for most of the variability (e.g., r square = 0.975) and an estimate of the residual in S is within the accuracy of field measurement. Using nonlinear regression and fitting both parameters independently does improve r square (=0.991), but only marginally. Using the scaling approach, an expression of soil physical properties was used in place of the independent parameter. The regression (r square = 0.967) gives values to the coefficients of physical properties in this expression allowing scale factors. properties in this expression, allowing scale factors to be calculated directly from physical properties. A jack-knife estimation technique was employed to show how well scale factors are calculated from show how went scale factors are caterated from physical properties alone. This methodology ac-counted for spatial variability adequately, offering a simple, computationally efficient representation in numerical simulation. Other data sets indicated that approach may be useful on a regional scale for clearly defined soil groups. (Author's abstract) W91-09961

HUMIC AND FULVIC ACID ADSORPTION BY SILICON AND ALUMINUM OXIDE SURFACES ON CLAY MINERALS.
National Chemical Lab. for Industry, Yatabe

For primary bibliographic entry see Field 2K.

CLAY MINERAL TYPE AND ORGANIC COM-POUND SORPTION BY HEXADECYLTRI-METHYLAMMONIUM-EXCHANGED CLAYS. Michigan State Univ., East Lansing. Dept. of Crop

For primary bibliographic entry see Field 5B.

COMPARISONS OF HUMIC SUBSTANCES EXTRACTED FROM CONTIGUOUS ALFISOLS AND MOLLISOLS OF SOUTHWESTERN

OHIO.
Savannah River Ecology Lab., Aiken, SC.
J. M. Novak, and N. E. Smeck.
Soil Science Society of America Journal SSSJD4,
Vol. 55, No. 1, p 96-102, January/February 1991. 5
fig, 5 tab, 30 ref.

Descriptors: \*Ohio, \*Soil analysis, \*Soil chemistry, \*Soil properties, \*Soil types, Alfisols, Fulvic acids, Humic acids, Humic substances, Mollisols, Nuclear magnetic resonance, Spectrophotometry

Humic acids (HA) and fulvic acids (FA) extracted from contiguous Alfisols and Mollisols were char-acterized to determine if any dissimilarities could be documented between humic substances extract-ed from soils formed under nearly identical environmental conditions, but belonging to different taxonomic classes. Comparisons of humic sub-stances from two Alfisol-Mollisol pairs, one from the Wisconsinan and one from the Illinoian till the Wisconsinan and one from the Illinoian till plain of southwestern Ohio, were based on we chemical, infrared, and 13C cross-polarization magic angle spinning nuclear magnetic resonance (CPMAS NMR) spectroscopy. Using 0.1 M NaOH, more humic substances were extracted from the Mollisols than the Alfisols, with the majority being HA. Small amounts of FA were recovered from all pedons. Data from infrared and 13C CPMAS NMR spectroscopy indicate that HA from both the Alfisols and Mollisols are dominated by alkyl-substituted aromatic structures, followed aliphatic, O-substituted alkyl, carboxylic acid, and small amounts of carbonyl structures. Whereas 13C NMR spectroscopy data suggest Mollisol HA 13C NMR spectroscopy data suggest Mollisol HA contain higher aromatic and carboxylic acid concontain higher aromatic and carboxylic acid con-tents than those of Alfisols, Alfisol HA spectra show more evidence for phenolic-OH groups and lignin and lignin-like products than those of Molli-sols. FA from Alfisols and Mollisols contained mostly aliphatic, O-substituted alkyl, and carboxyl-ic acid, followed by aromatic groups and small amounts of carbonyl groups. The proportion of nonaromatic and aromatic structures in the FA of the Alfisols and Mollisols was similar, but slight differences were noted in elemental ratios and 13C NMR spectra. Although only minimal differences NMR spectra. Although only minimal differences were noted among FA, differences were evident in the chemical and structural properties of HA from contiguous Alfisols and Mollisols in southwestern Ohio. (Author's abstract)

ACIDIFICATION INDUCED BY DIFFERENT NITROGEN SOURCES IN COLUMNS OF SE-LECTED TROPICAL SOILS.

International Fertilizer Development Center, Muscle Shoals, AL. For primary bibliographic entry see Field 5B. W91-09965

SAMPLING STRATEGIES FOR ASSESSING HYDRAULIC CONDUCTIVITY AND WATER-CONDUCTING VOIDS IN SAPROLITE. North Carolina State Univ., Raleigh. Dept. of Soil

Science. For primary bibliographic entry see Field 5E. W91-09966

DISPERSIVE EROSION AND ENTISOL-PAN-SPOT GENESIS IN SODIUM-AFFECTED LANDSCAPES.

North Dakota State Univ., Fargo. Dept. of Soil For primary bibliographic entry see Field 2J. W91-09967

LAND CLEARING AND USE IN THE HUMID NIGERIAN TROPICS: I, SOIL PHYSICAL

International Inst. of Tropical Agriculture, Ibadan

## Group 2G-Water In Soils

(Nigeria). B. S. Ghuman, R. Lal, and W. Shearer. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 178-183, January/February 1991. 4 fig, 5 tab, 25 ref.

Descriptors: \*Humid climates, \*Infiltration, \*Infiltration rate, \*Land clearing, \*Land use, \*Nigeria, \*Soil physical properties, \*Tropical regions, Cropping, Land management, Soil compaction, Soil physics, Soil texture.

Soil physical properties are affected by land clear-Soil physical properties are affected by land clear-ing use. Long-range planning in the humid tropics requires monitoring of these effects for an ex-tended period of time. The effects of two land-clearing methods and six land-use systems on soil physical properties of an Ultisol were studied for 4yr in the humid coastal belt of Nigeria. The land-clearing methods were bulldozer clearing with a shear blade and manual clearing. The six land-use systems were comprised of cassava-based crop-ping, oil palm-based cropping, alley cropping. ping, oil palm-based cropping, alley cropping, plantain, pasture, and improved forestry, all under plantain, pasture, and improved forestry, all under no-tillage. Soil physical properties were measured 90 d after clearing prior to planting, and at 2 and 4 yr after cropping. The soil texture of the 0-10-cm layer was not affected by clearing methods. Soil compaction increased to 30 cm with shear blade and 20 cm with manual clearing. With respect to the forested control, shear blade and manual clearthe forested control, shear olaide and manual clear-ing increased the bulk density in the 0-10-cm layer by 22 and 14%, respectively. The bulk density in the surface layer after 2 yr of cropping was signifi-cantly more for the pasture than the other systems. Three months after clearing, the steady infiltration rates were 89, 20 and 32 cm/h in the forested control, shear-blade and manually cleared plots, respectively. Infiltration rate increased to 47 and 51 cm/h in the shear-blade cleared and increased to 290 and then decreased to 156 cm/h in the manually cleared plots after 2 and 4 yr of cropping, respectively. (Author's abstract)

## INFLUENCE OF AGGREGATE SIZE AND MI-CRORELIEF ON DEVELOPMENT OF SUR-FACE SOIL CRUSTS.

Queensland Dept. of Primary Industries, Toowoomba (Australia). Wheat Research Inst. D. M. Freebairn, S. C. Gupta, and W. J. Rawls. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 188-195, January/February 1991. 10 fig, 2 tab, 30 ref.

Descriptors: \*Infiltration rate, \*Loam, \*Rainfall intensity, \*Soil aggregates, \*Soil crusts, \*Soil surfaces, \*Soil types, \*Soil water, Agronomy, Groundwater recharge, Particle size, Soil erosion.

The rate of water entry during rainfall has implications for crop agronomy, erosion, and groundwater recharge. The influences of aggregate size, microrelief and rainfall intensity on development of surface crusts and infiltration were investigated. Infiltration rate and hydraulic resistance of developing crusts on two soils under various surface conditions and simulated rainfall were measured. The two soils were Webster clay loam (fine loamy, mixed mesic Typic Haploquoll) and Port Barry, silt loam (fine-silty, mixed, mesic Typic Hapludoll). Aggregates with sizes of <1, <2, 1-2, 2-5, 5-19, 19-25 and 25-50 mm were studied. Final or steady-19-25 and 25-50 mm were studied. Final or steady-state infiltration rates were similar for all aggregate sizes of both soil types, but development of a soil crust was delayed when the surface was made up of aggregates > 19 mm in diameter. Large aggre-gates (clods) were a source of finer materials for the development of soil crusts. Microrelief effects were simulated by creating a ridge-furrow configu-ration in a box. Ridge-furrow microrelief did not influence total infiltration and was only effective in modifying the spatial distribution of water in the soil during the early phase of crust development. Infiltration rates, when measured using different rainfall intensities, could be described by a single curve when expressed as a function of cumulative curve when expressed as a function of cumulative rainfall rather than time. Total rainfall or rainfall energy may be better parameters for describing soil crust development than rainfall intensity. (Author's abstract) W91-09969

## SURFACE SEALING IN COASTAL PLAINS

LOAMY SANDS.
Georgia Univ., Athens. Dept. of Agronomy.
D. E. Radcliffe, L. T. West, R. K. Hubbard, and L. E. Asmussen. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 223-227, January/February 1991. 4 fig, 3 tab, 26 ref.

Descriptors: \*Coastal plains, \*Infiltration, \*Infiltration rate, \*Loam, \*Sandy soils, \*Soil sealants, \*Soil water, \*Surface sealing, Clay soils, Georgia, Rainfall infiltration, Rainfall simulators, Tillage.

Soil surface seals may consist of a dense surface skin seal and/or a washed-in layer of dispersed skm sear and/or a wasned-in layer or dispersed clay just below the surface. In Georgia, soils of the Piedmont region with clay contents above 10% can form low-permeability seals. In order to deter-mine if the more sandy soils of the Coastal Plain region would form seal, infiltration was measured using a rainfall simulator on bare and straw-covusing a rainfail simulator on bare and straw-cov-ered tilled soil at 6 sites on 3 loamy sands. The soils used were Tifton (fine-loamy, siliceous, thermic Plinthic Kandiudult), Carnegie (clayey, kaolinitic, thermic Plinthic Kandiudult), and Clarendon (fine-loamy, siliceous, thermic Plinthaquic Paleudult). Final infiltration rates were significantly lower in the bare soil at all but one site, indicating that sealing occurred. Final infiltration rates were not as low as those observed in soils from the Piedmont region of Georgia, probably due to the lower clay content of the Coastal Plains soils. Thincontent of the Court Frains souls. Infinisection micrographs suggested that these seals formed due to surface disruption with raindrop impact. Although grains that had been stripped of clay and oxides were observed at the surface, no distinct zones of clay and oxide concentration (washed-in layers) were observed. Size and spatial relationships of the areas of stripped grains sug-gested that they had been transported and redepos-ited rather than developed in place. (Author's abstract) W91-09972

## DRILLING METHOD FOR COLLECTION OF UNDISTURBED SOIL MONOLITHS.

Sveriges Lantbruksuniversitet, Uppsala. Div. of Agricultural Hydrotechnics. L. Persson, and L. Bergstrom. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 285-287, January/February 1991. 3 fig, 11 ref.

Descriptors: \*Core sampling, \*Drainage water, \*Drilling equipment, \*Hydraulics, \*Lysimeters, \*Soil aeration, \*Soil columns, \*Soil solution, \*Soil water, \*Solute transport, Barley, Fescues, Hydrau-

In studies of water and solute movement in soils, use of undisturbed monoliths is usually preferred. A drilling technique to collect such monoliths (0.295 m i.d.; 1.0, 0.5, or 0.3 m in length) with minimal soil disturbance was developed. The drill consists of a steel cylinder with four mounted cutting teeth at the bottom, into which a plastic casing is inserted. The drill-cylinder rotates around the casing and carves out a soil core that is gently pushed into the casing using only a minimum of hydraulic pressure. The technique has been was used in a wide variety of research applications within soil science, including the measurement of within soil science, inclining the measurement of hydraulic properties, soil evaporation, and soil aeration studies. During a 6-mo period in which the monoliths were used as filed lysimeters planted with either barley or meadow fescue, the lysimeters had much lower total drainage (106 compared with 213 mm for barley) and also lowers. pared with 213 mm for barrey) and also lower mean NO3 concentrations in the drainage water (<0.1 compared with 9.3 mg N/l). The uniformity of response among the replicates and large differ-ences between the two treatments was taken as indirect evidence that sidewell flows were of little significance when using this technique. (Author's abstract) W91-09975

EFFECT OF EARTHWORMS ON THE AGRO-CHEMICAL AND HYDROPHYSICAL PROP-ERTIES OF IRRIGATED SIEROZEMS,

Soyuzkhlopok Corporation, Tashkent, USSR. G. A. Bezborodov, and R. A. Khalbayeva. Soviet Soil Science SSSCAE, Vol. 22, No. 5, p 30-35, 1990. 2 fig, 1 tab, 7 ref.

Descriptors: \*Aggregates, \*Agriculture, \*Infiltra-tion, \*Irrigation, \*Oligochaetes, \*Soil physical properties, \*Soil water, \*USSR, Adsorption, Alfal-fa, Corn, Cotton, Nutrient concentrations, Soil po-rosity, Soil types, Soybeans, Wormcasts.

Soil containing earthworms, and their coprolites, have high concentrations of nutrients. The high concentrations of chemical elements in coprolites, concentrations or enemical elements in coprontes, which earthworms bring to the surface in the amount of 20 tons/ha/year, are of great importance in improving soil fertility. Analysis indicated that the amount of humus in the coprolites is 76% greater than in the soil, and that their water impact greater than in the soil, and that their water impact resistance is 7.4 times as great. A study in the United States investigated water uptake in pots without plants, and in pots containing soybean or corn plants. In each group, some of the pots contained no earthworms, and some contained 15 or 30 earthworms. The steady-state water uptake rate increased sharply in the pots containing earth-worms-by a factor of 6.1 in the pots without plants, and by factors of 6.9 and 15.3 (in the cases with 15 and 30 worms respectively) in the pots containing soybean and corn plants and factors of 8.5 and 12.8 in the pots containing corn plants. Comparative experiments were performed in order to determine the dynamics of water uptake by the soil, and the parameters of infiltration equations for the long-term irrigation of heavy-loam Sierozems of the Kelesskiy body, in the Chimkent Oblast, sown with cotton in the second year after plowing under alfalfa. Soils with earthworms had an infiltration rate of 0.02 m/h, while in soil w out earthworms, the infiltration rate was 0.003 m/ h. In field experiments where a constant flow of water was maintained at the surface of a soil containing a certain number of earthworms, steady-state infiltration was constant for 11 days. Depending on the irrigation procedure, The steady-state water uptake rate was found to be a function of different parameters. With constant moistening, was found to be a function of the number of earthworms, and with intermittent moistening, was found to be a function of the number of holes at the soil surface. (Brunone-PTT)

## ADSORPTION OF COPPER BY CERTAIN SOIL TYPES OF THE UKRAINE.

A. I. Karnaukhov, V. M. Tkachenko, and N. L. Shestidesyatnaya. oviet Soil Science SSSCAE, Vol. 22, No. 5, p 36-41, 1990. 1 fig, 3 tab, 14 ref.

Descriptors: \*Copper, \*Irrigation effects, \*Soil types, \*Trace metals, \*Ukraine, \*Water quality, Calcium chloride, Fertilizers, Organic matter, Plant physiology, Soil chemistry, Soil profiles.

The sorption of copper by organic and mineral components of the soil can have adverse effects on its uptake by plants. Investigating the factors on which this sorption depends has great relevance for ecological problems associated with the accu-mulation of copper in the soil profile as a result of irrigation with natural waters and effluents. One gram samples of air-dried soil were placed in 100 ml flasks with either double-distilled water or cal-cium chloride solution, and conner sulfate in the ml flasks with either double-distilled water or cal-cium chloride solution, and copper sulfate in the amounts of 1.9, 3.8, 7.6, 16, 25, 32, 64, and 128 mg Cu/L of solution. The ionic strength of each of the solutions remained constant. With an increasing concentration of organic matter in the soils, adconcentration of organic matter in the soils, adsorption of copper intensified. The varying adsorption of copper can be used to determine the optimum levels of application of copper fertilizers for various soils. (Brunone-PTT) W91-10015

TYPES OF STAGNANT MOISTURE ACCUMULATIONS IN SOILS OF HUMID LANDSCAPES AND THEIR MELIORATIVE AND AGRICULTURAL RATING.

Moscow State Univ. (USSR). Dept. of Soil Sci-

## Water In Soils—Group 2G

cnce. F. R. Zaydelman. Soviet Soil Science SSSCAE, Vol. 22, No. 5, p 58-66, 1990. 1 fig, 8 ref.

Descriptors: \*Humid areas, \*Soil physical proper-ties, \*Stagnant water, \*Waterlogging, Agriculture, Drainage, Gravity, Pore size, Soil porosity, Soil profiles, Water quality.

The main goal of draining the waterlogged soils of humid landscapes is to remove stagnant accumulations of gravitational water from their profile during the growing season. Long-term studies of the soil water regime of the non-Chernozem zone revealed the possible formation, in their profile, of reveated the possibile tormation, in their profile, in four types of stagnant moisture accumulation: pro-file, local subsurface, binary, and surface. These four types can be further subdivided into litholog-ic-hydrologic variants reflecting the relationship between the hydrologic characteristics of soils and their physical properties. These variants are close-ly associated with the causes of soil waterlogging, practices and procedures of soil drainage, and with the methods of stabilization of the water regime. Soil can change from one type of stagnant accumu-lation to another as a result of the effect of secondlation to another as a result of the effect of second-ary anthropogenic causes. For example, as a result of strong compaction, soils with a surface stagna-tion of gravitational water appear where earlier a binary type had been dominant, or where generally non-waterlogged soils without signs of distinct hy-dromorphism associated with one of the forms of stagnant moisture accumulation, had been preva-lent. In the latter case, this is usually attested to by the formation of a compacted gleved subsoil horithe formation of a compacted gleyed subsoil horizon in a profile of soils earlier free from signs of zon in a profile of soils earlier free from signs of hydromorphism. Nevertheless, despite a certain arbitariness, separation of the four types of stagnant moisture accumulation in a profile of soils of humid landscapes creates the necessary prerequisites for systematizing the measures needed to optimize their water regime. Based on this, conditions arise for developing, in detail, the design features of drainage systems and of systems for bilateral regulation of the soil water regime of excessively wet areas. (Brunone-PTT)

## REGULATION OF THE SOIL WATER REGIME UNDER FURROW IRRIGATION.

E. T. Pyagay. Soviet Soil Science SSSCAE, Vol. 22, No. 5, p 67-76, 1990, 1 tab, 6 ref.

Descriptors: \*Data interpretation, \*Furrow irriga-tion, \*Hydrologic models, \*Infiltration, \*Model studies, \*Soil water, Agriculture, Cotton, Flow rates, Irrigation, Irrigation practices, Mathematical equations, Root zone, Soil porosity.

An experimental computational method was proposed for determinating the irrigation regime of agricultural crops, and losses of irrigation water, by infiltration beyond the root zone of the soil, based on information on soil moisture suction or soil wetness. During periods of irrigation changes in the water content of the root zone depend mainly on the irrigation rate and the rate of infil-tration of moisture. Under furrow irrigation, the soil immediately below the furrows is wetted almost to maximum moisture capacity, while in the furrow spacing the moisture content of the soil usually does not exceed field capacity. Results of calculations of the irrigation regime of cotton by the proposed computational method showed that the irrigation rate and the rate of infiltration of irrigation water decrease as the soils become finer in texture and the water table rises. At average levels of soil saturation, more than 50% of the irrigation water is accounted for by wetting of the irrigation water is accounted for by wetting of the profile of the calculated root zone immediately below the furrow, and by a gravitational flow of moisture. The average change in moisture content throughout the root zone from the maximum to the minimum, but not below 65% of the field capacity, was equal to the irrigation rate for cotton. The proposed method of calculating the irrigation regime of agricultural crops and the water balance conforms to the requirements of reliability and simplicity of use needed to solve the practical problems in regulating and predicting the water and salt regimes of irrigated soils. (Brunone-PTT) W91-10017

SEASONAL DISTRIBUTION OF SULFUR FRACTIONS IN LOUISIANA SALT MARSH SOILS.

Louisiana State Univ., Baton Rouge. Lab. for Wet-Louisiana State Univ., Baton Rouge. Lao. 107 land Soils and Sediments. For primary bibliographic entry see Field 2L. W91-10172

INVESTIGATION OF AERATION POROSITY IN SOILS UNDER IRRIGATION.
Moscow State Univ. (USSR). Dept. of Soil Sci-

For primary bibliographic entry see Field 3F. W91-10192

RELATIONSHIPS BETWEEN SOIL STRUC-TURE AND TIME OF LANDSPREADING OF PIG SLURRY. Institute for Soil Chemistry, C.N.R., Via Corridoni 78, 56100 Pisa (Italy). For primary bibliographic entry see Field 5E. W91-10275

PHOSPHATE BALANCE IN LONG-TERM SEWAGE SLUDGE AND PIG SLURRY FER-TILIZED FIELD EXPERIMENT.
Forschungsanstalt für Agriculturchemie und Umwelthygiene, Schwarzenburgstr. 155, 3097-Liebe-feld (BE), Switzerland.

For primary bibliographic entry see Field 5E. W91-10283

SOIL CONDITIONS.

Brno Univ. (Czechoslovakia).
E. Klimo, and A. Prax.
IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures: Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 61-78, 6 fig, 12 tab, 7 ref.

Descriptors: \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Soil analysis, \*Soil properties, \*Soil water, Dyfe River, Soil chemistry, Soil physical properties, Soil stability, Soil texture.

The Dyfe River floodplain in Czechoslovakia is formed by the sedimentary complex of Pleistocene gravel-sand strata and Holocene alluvial loam strata. The area studied is situated in the floodplain forest, on the right bank of the river near Lednice na Morave. Soils are classified as vegas and/or paternies. The majority of soils have a heavy texpaternies. The inajority of soils have a neavy ex-ture with a high content of clayey particles, the soil exchangeable complex is saturated and the pH value indicates slightly acid or neutral conditions in soils. Soils are rich in nutrients, except phosphoin soils. Soils are rich in nutrients, except phosphorus. They show a considerable heterogeneity of physical and chemical properties. In the upper part of the soil profile, the value of the porosity is high and decreases with depth. The most remarkable changes in the course of the year appear in the value of the bulk density, and a linear dependence of this value on soil moisture is apparent. The fluctuation of soil moisture depends on the movements of the groundwater table as well as on precipitation. The maximum value of soil water content occurs in the spring and the minimum in the autumn. The course of soil "hydrolimits' and of the autumn. The course of soil 'hydrolimits' and of actual soil moisture in the soil profile indicates favorable moisture conditions in the whole profile. navorable moisture conditions in the whole profile. However, a deterioration in soil air content is evident, particularly in the lower part of the soil profile. Sufficient supplies of soil water support the stability of the floodplain forest ecosystem (See also W91-10298) (Author's abstract)

W91-10301

ACTIVITY OF DECOMPOSERS AND PROC-ESSES OF DECOMPOSITION IN SOIL. B. Grunda

IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985.

p 389-414, 7 fig, 15 tab, 21 ref.

Descriptors: \*Czechoslovakia, \*Decomposition, \*Flood plains, \*Floodplain forests, \*Soil bacteria, \*Soil fungi, \*Soil organisms, Climates, Detritus, Groundwater level, Litter, Microbial degradation, Seasonal variation, Soil water, Temperature.

Conditions for decomposer activity are controlled by soil properties, climate, and quantity and quality of decomposed material in a given locality. In the locality of Lednice na Morave, decomposer activity takes place in litter rich in mineral nutrients, from a variety of species on and in soil with favorable physical and chemical properties, and under conditions of sufficient moisture content and favorable temperatures. As a rule, aerobic bacteria represented 50 to 70% of the total amount of microorganisms; the corresponding values for actinomycetes, anaerobic bacteria and micromycetes were 20 to 30%, about 10% and only 1 to 2%, were 20 to 30%, about 10% and only 1 to 2%, respectively. There were 2 peaks (May-June and October) and 2 depressions (summer, winter) in the seasonal fluctuation of the total amount of microorganisms. The number of an nisms was closely correlated with the soil moisture and the groundwater level. Ammonifying micro-flora was very abundant in the soil. Cellulose decomposers represented a permanent component of soil microflora. Actinomycetes were the most abundant, while bacteria were the most active cellulose decomposers. The activity of soil catalase was high and closely correlated with soil moisture. The decomposition of cellulose showed a markedby periodic course, with a peak in summer and a close correlation with the course of soil temperature. The decomposition of leaves of the tree and shrub layer and of herbs was very intensive as early as the first period after fall; thereafter, more intensive decomposition was observed in late spring and early summer. CO2 production from the soil was a markedly periodic phenomenon, with the maximum in late spring or early summer and with a regular second peak in autumn. (See also W91-10298) (White-Reimer-PTT) W91-10306

ENZYMATIC ACTIVITY OF THE SOIL UNDER A FLOODPLAIN: FOREST AND ITS CONNECTION WITH THE BIOLOGICAL RECYCLING OF NUTRIENTS.

Z. Ambroz.

Z. Amoroz.

IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 415-424, 11 fig, 2 tab, 4 ref.

Descriptors: \*Cycling nutrients, \*Enzymes, \*Flood plains, \*Floodplain forests, \*Soil chemistry, Aeration, Decomposition, Microorganisms, Nitrogen, Organic matter, Phosphorus, Seasonal variation, Soil water.

The seasonal dynamics of the activity of invertase, amylase, cellulase, alkaline and neutral protease and alkaline and neutral phosphatase were studied in three profiles of alluvial soil under a floodplain soil from 1971-1972. At regular monthly intervals, soil samples from three soil pits were taken at depths of 2-7 cm and 20-25 cm, and after sieving depths of 2-1 cm and 20-25 cm, and atter seving through a 2mm sieve, they were used for enzymatic analyses. In the annual periodicity, periods of maximum enzymatic activity, associated with a predominance of mineralization of organic matter, alternate with periods of depression, when sorption of enzymes by the soil predominates, and at the same time conditions are formed for more intensive humification. Significant relationships were found between the activity of proteases and the content of readily available nitrogen, whereas water-solu-ble phosphorus reduces the activity of phosphatases. In the top soil layer, the enzymatic activity is significantly influenced by soil moisture, while in deeper layers, the influence of aeration is more marked. A connection between the number of microflora and the activity of enzymes was demonstrated in invertase and proteases. (See also W91-10298) (White-Reimer-PTT)

## Group 2G-Water In Soils

MEASUREMENTS OF SURFACE SOIL MOISTURE AND TEMPERATURE,

Agricultural Research Service, Beltsville, MD. Hydrology Lab. For primary bibliographic entry see Field 7B. W91-10376

REMOTE SENSING OF LITTER AND SOIL ORGANIC MATTER DECOMPOSITION IN FOREST ECOSYSTEMS.

New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space. For primary bibliographic entry see Field 7B. W91-10378

### 2H. Lakes

RELATIONS AMONG NAOH-EXTRACTABLE PHOSPHORUS, SUSPENDED SOLIDS, AND ORTHO-PHOSPHORUS IN STREAMS OF WY-

Wyoming Univ., Laramie. Dept. of Zoology and

For primary bibliographic entry see Field 5B. W91-09357

OBSERVATIONS ON THE WETLAND ECO-SYSTEM OF KABAR LAKE IN BEGUSARAI, BIHAR, WITH SPECIAL REFERENCE TO VEGETATION.

Botanical Survey of India, Howrah (India). N. C. Majumidar, B. Ghosh, and G. P. Singh. Bulletin of the Botanical Survey of India, Vol. 30, No. 1/4, p 134-139, 1988. 1 fig.

Descriptors: "Aquatic plants, "Drainage area, "Ecosystems, "India, "Lake ecology, "Limnology, "Macrophytes, "Species composition, "Wetlands, Agriculture, Aquatic habitats, Economic aspects, Kabar Lake, Lakes, Plant growth, Population dy-Vegetation.

An exploration survey was conducted, by the ecology section of the Botanical Survey of India, to make a thorough study of Kabar Lake of Bihar, India, and of the vegetation of the ecosystem. Kabar Lake is situated about 22 km north of Begusarai in the Begusarai district, with a drainage area of about 21 sq km during October. In the rainy season, the water in the lake increases in depth as ocason, the water in the lake increases in depth as well as area; in winter and summer the lake shrinks in size and depth. Aquatic vegetation grows abun-dantly in the lake, and can be classified into three types: rooted in the lake sediments, suspended in the water column, or free floating. types: rooted in the lake sealments, suspended in the water column, or free floating. Several varieties of Oryza sativa are cultivated in the lake, growing to a height of about a meter above the water surface at the time of harvest. To conserve the habitat, hunting of birds and catching of fish must be prohibited, and education programs should be instituted to make local inhabitants aware of be instituted to make local inhabitants aware of conservation's importance. Several thousand fami-lies of fishermen, locally called the Sahnis, reside around the lake and make their living through hunting and fishing. Their livelihoods will be se-verely disturbed with conservation measures in the lake, and arrangements should be made for alterna-tive sources of income. (Brunone-PTT) W91-09360

BIO-AQUATIC NATURE OF INDIAN BOTAN-IC GARDEN LAKES.
Botanical Survey of India, Howrah (India).
J. N. Singh, and M. K. Ghosh.
Bulletin of the Botanical Survey of India, Vol. 30, No. 1/4, p 161-167, 1988. 3 fig, 3 tab, 5 ref.

Descriptors: \*Aquatic habitats, \*India, \*Lake ecology, \*Limnology, \*Species composition, \*Urbanization, Alkalinity, Carbonates, Electrical conductivity, Evaporation, Hydrogen ion concentration, Indian Botanical Garden, Industrialization, Precipitation, Sluices, Trace elements, Water chemis-

The aquaphilous and terrestrial plant communities maintained at the Indian Botanical Garden are affected by the spread of urbanization and industri-

alization, and by the dynamic forces of riverine overflows. The aquatic environment of the garden consists of a mosaic of 25 interconnected lakes of consists of a mosaic of 25 interconnected takes of varying dimensions, linked with the River Ganga, with free access of water controlled by a sluice mechanism on the southeastern side. The lakes cover one-ninth of the total surface area of the botanical gardens. One composite water sample was taken from each lake under investigation at was taken from each lake under investigation at two month intervals for a year. Chemical concen-trations of trace ions, pH, and electrical conductive ty were analyzed. The Braun-Blanquet method was used to determine the phytosociological components of the aquatic habitats. The chemical nature of water from the River Hooghly interferes with the chemistry of lake waters, but does not appear to be a dominant factor. At times, the water level of these lakes is maintained by allowing inflow of river water through sluices. The values of pH and residual carbonate recorded indicate that the lake waters are always alkaline and have free residual carbonate. From August to Decem-ber, the rate of precipitation is higher than that of evaporation, while from February to June, the rate of evaporation is higher than that of precipitation. The lakes are subjected to high levels of human interference, which makes categorization of com-munities based on salt tolerance capacities difficult. The aquatic environment is ecologically diverse. The heterogeneity of the aquatic communities is due to the disposition of the water bodies in the garden and the impact of seasonal cycles, coupled with human interference. The formation of the present plant communities has not been a natural consequence of changes in climate and local condi-tions. (Brunone-PTT) W91-09361

IMPACT OF RIVERINE WETLANDS CON-STRUCTION AND OPERATION ON STREAM CHANNEL STABILITY: CONCEPTUAL FRAMEWORK FOR GEOMORPHIC ASSESS-MENT.

MENT.
Illinois Univ., Urbana. Dept. of Geography.
B. L. Rhoads, and M. V. Miller.
Environmental Management EMNGDC, Vol. 14,
No. 6, p 799-807, November/December 1990. 5 fig,
2 tab, 35 ref.

Descriptors: \*Chicago, \*Conservation, \*Environ-mental monitoring, \*Geomorphology, \*Resources management, \*Streams, \*Wetland mitigation, \*Wetlands, Aquatic habitats, Channel stability, Deposition, Ecosystems, Erosion, Sedimentation, Tributaries, Water quality.

Wetland conservation is a critical environmental management issue. An emerging approach to this issue involves the construction of wetland environments. Because understanding of wetlands function is incomplete, such projects must be monitored closely because they may have unanticipated im-pacts on ecological, hydrological and geomorpho-logical systems. Assessment of project-related im-pacts on stream channel stability is an important component of riverine wetlands construction and operation because enhanced erosion or deposition associated with unstable rivers can lead to loss of property, reductions in channel capacity, and deg-radation of water quality, aquatic habitat, and ri-parian aesthetics. The watershed budget concept provides a scientific framework for evaluating the impact of riverine wetlands construction and operation on stream channel stability. This concept is based on the principle of conservation of mass, i. e. the total amount of water and sediment moving through a specific reach of river must be con-served. Long-term measurements of channel sediment storage and other water/sediment budget components provide the basis for distinguishing between project-related impacts and those result-ing from other causes. Changes in channel sediment storage that occur as a result of changes in internal inputs of water or sediment signal a project-related impact, whereas those associated with changes in upstream or tributary inputs denote a change in environmental conditions elsewhere in the watershed. A geomorphic assessment program based on the water/sediment budget concept has been implemented at the site of the Des Plaines River Wetlands Demonstration Projection near Chicago. Channel sediment storage changed

little during the initial construction phase, suggesting that the project has not yet affected channel stability. (Author's abstract)

CONVECTIVE MOTIONS IN THE SIDEARM OF A SMALL RESERVOIR.

Stanford Univ., CA. Dept. of Civil Engineering. S. G. Monismith, J. Imberger, and M. L. Morison. Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1676-1702, December 1990. 17 fig, 31 ref.

Descriptors: \*Diurnal variation, \*Lake morpholo-Descriptors: "Duffinal variation," Lake morphology, "Limnology, "Reservoirs, "Temperature gradient, Cooling, Heating, Hydrological models, Siphons, Storage reservoirs, Surface water, Turbulence, Water circulation, Water temperature.

Horizontal temperature gradients are formed diurnally in the surface waters of a sidearm of a small water supply reservoir at a time during summer when radiative heating and vertical stratification of the reservoir's waters were both quite strong. Be-cause the closed end of the sidearm was relatively cause the closed end of the sidearin was feraltively shallow, daytime heating and nighttime cooling created larger temperature changes there than in the body of the lake, resulting in large horizontal temperature gradients that drove strongly sheared, horizontal exchanges. Because of more vigorous turbulent mixing during cooling, cooling-driven flows were slower and of greater vertical extent than were heating-driven flows. The overall flow exhibited inertia in that it was not in phase with the exhibited inertia in that it was not in phase with the daily heating cycle. A net residual flow, with surface waters flowing out and metalimnetic waters flowing in, occurred when averaged over the daily cycle. The thermally driven flow, the 'thermal siphon', greatly enhanced the rate of horizontal exchange between the sidearm and the body of the reservoir such that the time required to replace water in the sidearm when the siphon is operating is substantially less than estimates with conventional formulae based on horizontal turbulent diffusion. (Author's abstract) W91-09409

SEASONAL REGULATION OF DAPHNIA POPULATIONS BY PLANKTIVOROUS FISH: IMPLICATIONS FOR THE SPRING CLEAR-WATER PHASE.

WALER FHASE.
Wisconsin Univ.-Madison. Center for Limnology.
C. Luecke, M. J. Vanni, J. J. Magnuson, J. F.
Kitchell, and P. T. Jacobson.
Limnology and Oceanography LIOCAH, Vol. 35,
No. 8, p 1718-1733, December 1990. 7 fig, 7 tab, 44
ref. Federal Aid in Sport Fish Restoration Act
Project E-95. P. Project F-95-P

Descriptors: \*Fish behavior, \*Limnology, \*Phyto-plankton, \*Population dynamics, \*Predation, \*Wa-terfleas, \*Wisconsin, \*Zooplankton, Algal blooms, Algal growth, Eutrophic lakes, Limiting nutrients, Population density, Seasonal distribution, Seasonal variation, Transparency.

A distinct clear-water phase characterized by high Secchi disk transparency and low phytoplankton biomass occurs each spring in many mesotrophic and eutrophic lakes. The ability of planktivorous and eutrophic lakes. The ability of planktivorous fish to regulate the population dynamics of Daphnia galeata in Lake Mendota, Wisconsin, was examined during spring and summer of 1987. Low rates of consumption by yellow perch (Perca flavescens) and cisco (Coregonus artedii) allowed consultation of Debette control and district the control of the cont flavescens) and cisco (Coregonus artedii) allowed populations of D. galeata to expand rapidly during spring, resulting in a distinct clear-water period that lasted from mid-May until early June. A subsequent decline in D. galeata abundance resulted from low food availability brought about by exploitation of algal resources. Once populations of D. galeata were reduced, predation by perch and cisco was sufficient to keep populations of D. galeata at low densities during July and August in spite of more abundant algal food resources. Extreme seasonal variations in the degree to which spite of initie and an additions in the degree to which planktivorous fish can regulate daphnid population dynamics may have allowed daphnids to persist in Lake Mendota during the past century in the presence of abundant zooplanktivores. (Author's abW91-09410

BACTERIAL PRODUCTION ON HUMIC AND NONHUMIC COMPONENTS OF DISSOLVED ORGANIC CARRON.

ORGANIC CARBON, Georgia Univ., Athens. Dept. of Microbiology. M. A. Morgan, and R. E. Hodson. Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1744-1756, December 1990. 1 fig, 3 tab, 39 ref. US DOE/Savannah River Ecology Laboratory Contract DE-AC09-76SR00-819, NSF Grant BSR 88-06255.

Descriptors: \*Bacterial physiology, \*Dissolved organic carbon, \*Dystrophic lakes, \*Humic substances, \*Limnology, Aquatic habitats, Biodegradation, Lakes, Marshes, Nutrient concentrations, Organic carbon, Population density.

Dissolved humic substances make up approximate-Dissolved numic substances make up approximate-ty 50% or more of the dissolved organic carbon (DOC) in freshwater ecosystems, yet their tropho-dynamic roles remain unresolved. DOC was sepa-rated from two freshwater environments, a lake and a blackwater marsh, into two fractions, humic DOC and nonhumic DOC, using an XAD-8 resin to selectively adsorb the humic substances. Results of microcosm studies revealed that the humic fraction of DOC was used by natural bacterial assem-blages from the lake and marsh as a carbon and energy source, as indicated both by increases in bacterial biovolume and rates of bacterial incorpobacterial biovolume and rates of bacterial incorpo-ration of tritiated thymidine. Humic substances supported fourfold less bacterial secondary pro-duction per unit of initial carbon, however, than did nonhumic substances from the same environ-ment. Bacterial utilization of humic compounds accounted for a significant fraction of the total bacterial production on DOC, measured as in-creases in bacterial biovolume. Humic substances supported an average of 22% of total growth on DOC from the lake and 53% of the total growth on DOC from the marsh. The relative bioavailabi-lity of both the humic and nonhumic fractions of lity of both the humic and nonhumic fractions of DOC differed between the lake and blackwater marsh, with less bacterial production per unit of initial carbon occurring on marsh-derived dis-solved compounds. (Author's abstract) W91-09411

TWENTIETH-CENTURY SALINITY AND WATER-LEVEL FLUCTUATIONS IN DEVILS LAKE, NORTH DAKOTA: TEST OF A DIATOM-BASED TRANSFER FUNCTION. Minnesota Univ., Minneapolis. Limnological Research Center.

S. C. Fritz.

Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1771-1781, December 1990. 7 fig,1 tab, 21 ref. NSF Grants DEB 80-04286 and BSR 84-15866.

Descriptors: \*Bioindicators, \*Cores, \*Diatoms, \*Limnology, \*North Dakota, \*Paleohydrology, \*Salinity, \*Species composition, \*Water level fluctuations, Arid regions, Comparison studies, Devils Lake, History, Prediction, Semiarid regions, Transfer function.

Diatom surface-sediment assemblages and associated water chemistry data are used to develop a transfer function for the quantitative reconstruction of salinity change in the northern Great Plains of North America. The transfer function, derived from canonical correspondence analysis of the surface-sample data, is applied to a core from Devils Lake in sediments encompassing the last century. The accuracy of the calibration equation is tested by comparing the diatom-inferred salinity with documented salinity and water level data recorded for the lake over the last 100 years. The diatomfor the lake over the last 100 years. The diatom-based reconstruction shows good agreement with the historical data, particularly in freshwater and at low to moderate salinities. Discrepancies between the measured and diatom-inferred salinity during high salinity periods may reflect inadequacies with the inference method or problems in the sedimen-tary record of the lake related to poor diatom preservation, sediment mixing and reworking, and preservation, sediment mixing and reworking, and dating inaccuracies. This diatom-based inference method for salinity reconstruction represents a powerful tool for paleohydrological and paleocli-

matic reconstruction in semiarid and arid regions.

HETEROTROPHIC, AUTOTROPHIC, AND MIXOTROPHIC NANOFLAGELLATES: SEASONAL ABUNDANCES AND BACTERIVORY IN A EUTROPHIC LAKE, Georgia Univ., Athens. Dept. of Zoology. For primary bibliographic entry see Field 5C. W91-09415

COMPARISON OF PHYTOPLANKTON BIO-MASS IN TEMPERATE AND TROPICAL

Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology. W. M. Lewis.

Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1838-1845, December 1990. 3 fig, 3 tab, 28

Descriptors: \*Biomass, \*Lakes, \*Limnology, \*Phytoplankton, \*Temperate zone, \*Tropical regions, Algal growth, Comparison studies, Eutrophic lakes, Growing season, Oligotrophic lakes, Seasonal variation, Stratification, Trophic level.

A large fraction of the variation in annual avera A large fraction of the variation in annual average biomass among lakes can be explained by the length of the growing season, which varies with latitude. Phytoplankton biomass is compared for sixteen temperate and five tropical lakes that are sufficiently deep to develop seasonal stratification. The ratio of annual mean to maximum biomass averages 0.45 for tropical lakes and is significantly lower, for temperate lakes (0.36). Seasonal (3. lower for temperate lakes (0.36). Seasonal (3-month peak) ratios of mean to maximum biomass month peak) ratios of mean to maximum biomass (approximately 0.7) do not differ for oligotrophic tropical and temperate lakes, but the ratios for temperate lakes fall below those of tropical lakes at higher trophic states. Tropical lakes of given trophic state have a higher minimum biomass than temperate lakes of the same trophic state; both temperate and tropical lakes show a strong increase in minimum biomass with increasing maximum biomass. The relative range of annual variation for temperate lakes is approximately 40% greater than for tropical lakes. Differences in the stability of layering and in the duration of seasonal mixing explain much of the difference in variability of biomass for tropical and temperate lakes that stratify. (Author's abstract)

16S RRNA SEQUENCES OF UNCULTIVATED HOT SPRING CYANOBACTERIAL MAT INHABITANTS RETRIEVED AS RANDOMLY PRIMED CDNA.

Montana State Univ., Bozeman. Dept. of Microbi-

ology. R. Weller, J. W. Weller, and D. M. Ward. Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 1146-1151, April 1991. 4 fig, 1 tab, 32 ref. NSF Grant BSR-8907611.

Descriptors: \*Algae, \*Cyanophyta, \*Genetics, \*Hot springs, \*Nucleic acids, \*Taxonomy, DNA, Ecology, Octopus Spring, Primary productivity, RNA, Sampling.

Cloning and analysis of cDNAs synthesized from Cloning and analysis of cDnAs synthesized from rRNAs is one approach to assess the species composition of natural microbial communities. In some earlier attempts to synthesize cDNA from 16S rRNA (16S rcDNA) from the Octopus Spring cyanobacterial mat (from Yellowstone National Park), a dominance of short 16S rcDNAs was observed, which appear to have originated only from certain organisms. Priming of cDNA synthesis from small ribosomal subunit RNA with random deoxyhexanucleotides can retrieve longer random deoxyneamutectomes can retrieve longer sequences, more suitable for phylogenetic analysis. The retrieval of 16S rRNA sequences from three formerly uncultured community members is reported. One sequence type, which was retrieved three times from a total of five sequences analyzed, can be placed in the cyanobacterial phylum. A second sequence type is related to 16S rRNAs from green nonsulfur bacteria. The third sequence

type may represent a novel phylogenetic type. The specific organism contributing the cyanobacterium sequence is not Synechococcus lividus, the organism suspected of dominating this mat community. This sequence might represent the dominant matbuil.ling primary producer in this community.
(Doria-PTT) W91-09447

GROWTH AND SURVIVAL OF BORDETELLA BRONCHISEPTICA IN NATURAL WATERS AND IN BUFFERED SALINE WITHOUT ADDED NUTRIENTS.

Glasgow Univ. (Scotland). Dept. of Microbiology. For primary bibliographic entry see Field 5B. W91-09448

EVIDENCE FOR THE RESTORATION OF THE LAKE ERIE ECOSYSTEM.

State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.

For primary bibliographic entry see Field 5G. W91-09452

CONCEPT OF A HYDROPHYTE FOR WEI-LAND IDENTIFICATION.

Fish and Wildlife Service, Newton Corner, MA. R. W. Tiner. Bioscience BISNAS, Vol. 41, No. 4, p 236-247, April 1991. 7 fig, 5 tab, 62 ref.

Descriptors: \*Hydrophytes, \*Indicators, \*Plant populations, \*Wetlands, Ecology, Hydrologic properties, Plant morphology, Regulations, Soil properties, Species composition, Vegetation.

'Hydrophytic vegetation' is a major determi federally regulated wetlands and is the chief deter-minant for regulation in some states. Therefore, it has become increasingly important to specify plants as wetland indicators. The concept of 'hydrophyte' should not be restricted to species but must be applied to individual plants adapted for life in water or saturated soils. The individualistic conin water or saturates onis. The individualistic con-cept of a hydrophyte recognizes that plant species may exhibit considerable plasticity or ecological amplitude in their adaptations to wet environ-ments. The existence of wetland ecotypes lacking ments. The existence of wertiand ecotypes tacking distinguishing morphological characteristics to separate them from the typical species and the broad ecological amplitude or wide wetness tolerance of many species make it difficult to rely solely on plant community composition to identify many wetlands and delineate their boundaries. Consequently, evaluation of soil properties and other hydrologic characteristics is essential to accurate identification and delineation of wetlands. It is not only the vegetation that makes wetlands important; their soils, hydrology, and landscape position fa-cilitate, for example, the interception of flood water and surface water runoff and the assimilation of nutrients and pollutants. Thus, although hydrophytic vegetation is still important for identifying and delineating wetlands, it is no longer the sole criterion. (Doria-PTT) W91-09453

EFFECT OF THE OPERATION OF A PUMPED-STORAGE STATION ON THE THERMAL REGIME OF A NATURAL WATER

For primary bibliographic entry see Field 5G. W91-09455

PREDICTION OF THE CHANGE IN THE WATER LEVEL OF LAKE SAREZ AND CHARACTERISTICS OF SEEPAGE THROUGH THE USOI BARRIER.

For primary bibliographic entry see Field 8A. W91-09462

ESTIMATED WATER-QUALITY CONDITIONS AND POTENTIAL DOWNSTREAM CHANNEL EFFECTS OF THE PROPOSED ROCK CREEK AND WOLFORD MOUNTAIN RESERVOIRS, NORTH CENTRAL COLORADO.

## **Group 2H—Lakes**

Geological Survey, Grand Junction, CO. Water Resources Div. D. L. Butler.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4177, 1990. 101p, 44 fig, 24 tab, 52 ref.

Descriptors: \*Dam effects, \*Thermal stratification, \*Water quality, Algal growth, Channel morphology, Chlorophyll, Colorado, Nitrogen, Phosphorus, Reservoir sites, Sedimentation rates.

Temperature distribution and water-quality conditions were evaluated for the proposed Rock Creek and Wolford Mountain Reservoirs in north-central Colorado. Simulated maximum surface temperatures in summer were 17 C for Rock Creek Reservoir and 19 C for Wolford Mountain Reservoir. voir and 19 C for Wolford Mountain Reservoir. Thermal stratification could develop in both reservoirs during most years. Elevation of the outlet would affect the thermal structure of Wolford Mountain Reservoir. Total-phosphorus and nitrogen concentrations and chlorophyll-a concentrations were estimated using empirical models and water-quality data collected from 1985 to 1987. Simulated total-phosphorus concentrations ranged from 0.007 to 0.019 mg/L for Rock Creek Reservoir and from 0.049 to 0.11 mg/L for Wolford Mountain Reservoir. Simulated total-nitrogen concentrations were about 0.3 to 0.4 mg/L for Rock Creek Reservoir and about 0.7 to 0.8 mg/L for Wolford Mountain Reservoir. Estimates of chlorophyll-a concentrations for Rock Creek Reservoir and servoir. pnyli-a concentrations for Nock Creek Reservoir, were similar to measured chlorophyll-a concentra-tions at nearby reservoirs. Models based only on total-phosphorus concentrations may overestimate chlorophyll-a concentrations in Wolford Mountain chlorophyli-a concentrations in Wolford Mountain Reservoir. Estimates of sediment discharge and sedimentation rates for the proposed reservoir sites were not substantially different than previously published results. The percentage loss of storage capacity after 100 years was less than 1% for Rock Creek Reservoir and about 11 percent for Wolford Mountain Preservoir. A being study of channel pro-Creek Reservoir and about 11 percent for Wolford Mountain Reservoir. A brief study of channel morphology indicates that channel degradation would not be substantial in a short reach downstream from the proposed damsites. (USGS) W91-09491

SURFACE-WATER HYDROLOGY OF HONEY LAKE VALLEY, LASSEN COUNTY, CALIFOR-NIA, AND WASHOE COUNTY, NEVADA. Geological Survey, Carson City, NV. Water Re-

sources Div. For primary bibliographic entry see Field 7C.

TRANSFERRING MODELS: THE CASE OF THE PHYSICAL HABITAT SIMULATION

FITSICAL HABITAT SIMULAT SYSTEM. Fish and Wildlife Service, Fort Collins, CO. For primary bibliographic entry see Field 7C. W91-09602

WATER QUALITY MODELING OF A CHAIN OF LAKES IN A RAPIDLY-DEVELOPING SUBURBAN AREA USING THE WERM

Montgomery (James M.) Consulting Engineers, Inc., Wayzata, MN. For primary bibliographic entry see Field 5G. W91-09610

MICROBIAL DECOMPOSITION

Centre d'Enseignement et de Recherche pour la Gestion des Ressources Naturelles et l'Environnement, Paris (France). For primary bibliographic entry see Field 7C. W91-09622

NITRIFICATION.

Tokyo Univ. (Japan). Dept. of Urban Engineering. For primary bibliographic entry see Field 2K.

PREDATOR-PREY INTERACTIONS.

Georgia Univ., Athens. Inst. of Ecology. For primary bibliographic entry see Field 7C. W91-09624

PRIMARY PRODUCTIVITY.

New York State Museum, Albany. Science Service

Div. C. D. Collins, and R. A. Park.

N: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 299-330. 9 fig. 1 tab, 74 ref.

Descriptors: \*Aquatic productivity, \*Computer models, \*Macrophytes, \*Model studies, \*Phytoplankton, \*Plant growth, 'Primary productivity, Algal growth, Biomass, Excretion, Photosynthesis, Prediction, Productivity, Respiration.

Aquatic primary productivity encompasses the growth (accumulation of biomass) of both phytoplankton and macrophytes—the basis for most aquatic ecosystems. It is of particular concern in water quality management because uncontrolled growth can cause taste and odor problems, unsightly algal scums, oxygen depletion in deeper waters, and aquatic weed beds that impede recreational and navigational uses of water bodies. The processes that contribute to primary productivity exhibit complex environmental relationships that are often difficult to measure and that do not lend themselves to simple, intuitive analysis. For this themselves to simple, intuitive analysis. For this reason, simulation models have been used for the past twenty years to provide insights into the mechanisms of primary productivity and to pro-vide predictions of changes in productivity based on changing environmental conditions. The measurement of primary productivity involves direct or indirect measurement of photosynthesis or the resulting biomass. However, in order to model pro-ductivity the loss terms (i.e., respiration, excretion, ductivity the loss terms (i.e., respiration, excretion, non-predatory and predatory mortality, and sinking) must also be considered. Algal models, like other models, should have the minimum level of complexity consistent with the objectives. The effort expended in programming, calibration, and evaluation increases geometrically with complexity. In the past when programming a model, it was usually easier to simplify code at a later date than to make it more complex. However, modular, structured code that is being produced now by most modelling groups can be modified with relative ease. (See also W91-09611) (Korn-PTT)

FISH GROWTH. Miljoestyrelsen, Silkeborg (Denmark). Freshwater

For primary bibliographic entry see Field 7C.

SEDIMENT-WATER EXCHANGE MODELS. Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab. For primary bibliographic entry see Field 7C. W91-09627

WATER-LEVEL FLUCTUATIONS IN LAKE ONTARIO OVER THE LAST 4000 YEARS AS RECORDED IN THE CATARAQUI RIVER LAGOON, KINGSTON, ONTARIO.
Queen's Univ., Kingston (Ontario). Dept. of Geo-

logical Sciences.
R. W. Dalrymple, and J. S. Carey.

Canadian Journal of Earth Sciences CJESAP, Vol. 27, No. 10, p 1330-1338, 1990. 8 fig, 49 ref.

Descriptors: \*Great Lakes, \*Lagoons, \*Lake Ontario, \*Ontario, \*Water level fluctuations, Canada, Clays, Climatic changes, Deposition, Lake sediments, Organic matter, Paleoclimatology, Radioactive dating, Silt.

The modern sediments in the Cataraqui River lagoon and marsh (Kingston, Ontario, Canada) consist of mixtures of organic material and clayey silts, the organic content of which increases as water depth decreases; gyttjas are accumulating in the deeper water parts of the lagoon, whereas peat

is the dominant sediment in the very shallow water portion of the lagoon (<0.7 m) and in the adjacent marsh. Cores show that one partial (modern) and two complete depositional cycles (gyttja over peat) are abrupt. These cycles are interpreted as resulting from fluctuations in the level of Lake Ontario about the long-term rising trend. Radio-carbon dates show that relatively low levels pre-vailed from 4100 to 3300 BP and from 2300 to 1900 vailed from 4100 to 3300 BP and from 2300 to 1900 BP; rapid rises in water level, which are indicated by the abrupt contact between cycles, occurred at 3300-3100 BP and some time between 2000 and 1500 BP. These water-level changes are synchronous with those shown by other studies in Lake Ontario and with century-scale paleoclimatic events. The high stands correlate with wet periods, and perhaps also with warm periods in the eastern part of the Great Lakes basin, but an inverse relationship between precipitation and temperature in the western Great Lakes suggests that the Great Lakes basin does not respond uniformly to climatic changes. (Author's abstract) changes. (Author's abstract) W91-09689

OCCURRENCE OF CYPRINIDAE AND OTHER SMALL FISH SPECIES IN RELATION TO PH IN ONTARIO LAKES.

Ontario Ministry of Natural Resources, Toronto. Fisheries Branch. For primary bibliographic entry see Field 5C. W91-09765

FACTORS INFLUENCING MERCURY CON-CENTRATION IN WALLEYES IN NORTHERN WISCONSIN LAKES.

National Fisheries Contaminant Research Center, La Crosse, WI. Field Research Station. For primary bibliographic entry see Field 5B. W91-09766

SEEPAGE INVESTIGATION. Engineering Associates, Madison, WI. For primary bibliographic entry see Field 8G. W91-09771

URANIUM-SERIES AGE ESTIMATES AND PA-LEOCLIMATIC SIGNIFICANCE OF PLEISTO-CENE TUFAS FROM THE LAHONTAN BASIN, CALIFORNIA AND NEVADA.

Lamont-Doherty Geological Observatory, Pali-

Y. Lao, and L. Benson. Quaternary Research QRESAV, Vol. 30, p 165-176, 1988. 6 fig, 3 tab, 39 ref. NSF Grant OCE 85-

Descriptors: \*Lake basins, \*Paleoclimatology, \*Paleohydrology, \*Radioactive dating, \*Uranium radioisotopes, \*Water level fluctuations, California, Glacier balance, Lake sediments, Nevada,

Since the initial application of the radiocarbon method to dating of lake deposits in the Lahontan basin of Nevada and California, several refinements of the lake-level record have been attempted using a selection procedure that discriminates between pristine and altered inorganic carbon samples (tufa). In principle, the radiocarbon method can be used to date samples <70,000 yr old, but in practice contamination processes usually limit the application of the method to samples <20,000 yr old. In order to determine whether uranium-series (U-series) techniques of age estimation can be sucold. In order to determine whether transition-series (U-series) techniques of age estimation can be successfully applied to certain samples >20,000 yr old, the distribution of the isotopes of uranium and thorium in water and sediment from two drainage systems in the Lahontan basin were examined. It was found that an extended chronology of Lahonwas found that an extended chronology of Lahon-tan basin lake levels based on U-series age esti-mates correlates with the global ice-volume record. Lake highstands occur at or shortly after times of maximum ice-sheet size. Moderate size lakes occur when the global ice volume is about 80% of its maximum. The data indicate that lake levels rise and fall relative to the proximity of the mean position of the jetstream. When the continen-tal ice sheet is above some threshold size or shape,

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it appears that the large-scale circulation and climatic conditions are right for producing lakes of moderate to large size within the Lahontan basin. To substantiate clearly the correlation between the ice-sheet record and the lake-level record, cores ice-sneet record and the lake-level record, cores that contain sediments > 400,00 yr old need to be taken from several lake basins located within the Great Basin and analyzed for a variety of proxyclimate records. (Fish-PTT) W91-09791

USE OF TOTAL LAKE-SURFACE AREA AS AN INDICATOR OF CLIMATIC CHANGE: EXAMPLES FROM THE LAHONTAN BASIN.

Geological Survey, Denver, CO. L. V. Benson, and F. L. Paillet. Quaternary Research QRESAV, Vol. 32, p 262-275, 1989. 8 fig, 5 tab, 20 ref.

Descriptors: \*Climatic changes, \*Lake basins, \*Lake morphology, \*Paleoclimatology, \*Paleohydrology, \*Water surface profiles, California, Nevada, Paleolimnology, Time series analysis,

Variation in the size of a closed-basin lake has long been considered to represent the integrated re-sponse of a basin's hydrologic system to climatic change. The lake-level record for one closed-basin system (Lake Lahontan on the California-Nevada border) was examined in terms of existing topo-graphic and hydrologic features that have con-strained its variation. It was found that the proper gage of lake response to change in the hydrologic gage of lake response to change in the hydrologic balance is neither lake depth (level) nor lake volume but instead lake-surface area. Normalizavolume but instead take-surface area. Normaliza-tion of surface area is necessary when comparing surface areas of lakes in basins having different topographies. To a first approximation, normaliza-tion can be accomplished by dividing the paleosur-face area of a lake by its mean-historical, recon-structed surface area. For a closed-basin system composed of more than one subbasin, lake-level composed of more than one subosain, lake-level change is not an appropriate quantitative indicator of climatic change. The sum of the surface areas of lakes in each of the subbasins is a better indicator. Spill from one subbasin to an adjoining subbasin stabilized lake level in the spilling subbasin even though significant changes in the hydrologic balance and regional climate occur. River diversion can cause a lake in one subbasin to rise and a lake in another subbasin to fall while climate is constant. These conclusions dictate that when possible lake-level time-series records should be obtained for all subbasins in a closed-basin system. They also dictate that each subbasin lake-level time-series record should be converted to a time-series record of lake-surface area through the application of calculated lake-level/lake-surface area relationships. (Fish-PTT) W91-09792

WATER-QUALITY CHARACTERISTICS OF INFLOW TO AND OUTFLOW FROM B. EVER-ETT JORDAN LAKE, NORTH CAROLINA, 1982-86.

Geological Survey, Raleigh, NC. Water Resources For primary bibliographic entry see Field 2E. W91-09819

WATER-QUALITY CHARACTERISTICS INFLOW TO AND OUTFLOW FROM FALLS LAKE, NORTH CAROLINA, 1982-87. Geological Survey, Raleigh, NC. Water Resources

Div. For primary bibliographic entry see Field 2E. W91-09820

GROUND-WATER LEVELS AND QUALITY AT CREX MEADOWS WILDLIFE AREA, BURNETT COUNTY, WISCONSIN.
Geological Survey, Madison, WI. Water Re-

sources Div. For primary bibliographic entry see Field 2F. W91-09839

POPULATION ECOLOGY OF A PELAGIC FISH, XENOMELANIRIS VENEZUELAE

(ATHERINIDAE), IN LAKE VALENCIA, VEN-

EZUELA.

Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.

P. A. Unger, and W. M. Lewis.

Ecology ECOLAR, Vol. 72, No. 2, p 440-456, April 1991. 10 fig., 7 tab, 77 ref. NSF Grants DEB 76-04300, DEB 78-05342, and DEB 80-03883.

Descriptors: \*Fish diets, \*Limnology, \*Population dynamics, \*Silverside, \*Trophic level, \*Venezuela, Anoxia, Biomass, Carrying capacity, Copepods, Fishkill, Food chains, Mathematical models, Phantom-midges, Rotifers, Spawning, Zooplankton.

The population dynamics of Xenomelaniris, a small planktivorous fish which consumes zooplankton in open water, was studied for two years in Lake Valencia, Venezuela to demonstrate the mecha-Valencia, Venezuela to demonstrate the mechanism of trophic bottleneck, a common phenomenon in pelagic food chains of large tropical lakes. The population showed an annual cycle of abundance with continuous spawning in the littoral zone throughout the year. However, larvae survived only when rotifer densities exceeded 100 individuals/L. Steady mortality of spawning fish was due to predation while catastrophic mortality was due to anoxia during the early seasonal mixing. This fish showed a strong ontogenic shift of diet from rotifers during early development to copeods and Chaoborus during later development. pods and Chaoborus during later development.
Although Xenomelaniris was the only planktivore capable of consuming all major zooplankton taxa, it consumed only 3.6% of zooplankton production it consumed only 3.6% of zooplankton production because it never became sufficiently abundant to exploit its food resource fully. Total growth of Xenomelaniris conformed to the same equation as somatic growth of juveniles. The annual ratio of production of biomass was high, reflecting food sufficiency, a long growing season, and continuous loss of older fish to spawning mortality. Actual Xenomelaniris production was only one third of potential production based on the observed zooplankton production and the measured growth effiplankton production and the measured growth effi-ciency of this fish. This demonstration of trophic cency of this isn. Inis demonstration of ropine bottleneck is attributed to larval mortality, apparently through starvation, since it restricted the reproductive output of Xenomelaniris, which could otherwise have brought the population to carrying capacity. (Medina-PTT) W91-09916

DIURNAL PHOTOSYNTHESIS CYCLE IN CAM AND NON-CAM SEASONAL-POOL AOUATIC MACROPHYTES.

Occidental Coll., Los Angeles, CA. Dept. of Biol-

ogy. J. E. Keeley, and D. R. Sandquist. Ecology ECOLAR, Vol. 72, No. 2, p 716-727, April 1991. 5 fig, 7 tab, 18 ref.

Descriptors: \*Aquatic insects, \*California, \*Carbon fixation, \*Diurnal variation, \*Limnology, \*Macrophytes, \*Photosynthesis, Biomass, Carbon dioxide, Carbon radioisotopes, Crassulacean acid, Dissolved oxygen, Downingia, Hydrogen ion concentration, Plagiobothrys, Quillworts, Seasonal variation, Spikerushes, Tracer studies.

Seasonal pools in southern California undergo marked diurnal changes in pH, free carbon dioxide, and oxygen levels. Previous studies showed that Isoetes howellii utilized crassulacean acid metabo-Isoetes howellii utilized crassulacean acid metabolism (CAM) photosynthesis as means of assimilating carbon at night when ambient carbon dioxide levels are high. However, much of the pool flora was not CAM. It was hypothesized that coexistence under extreme carbon-limiting conditions would select for other photosynthetic characteristics in these non-CAM species. Quantitative carbon uptake measurements were made in the field on the CAM I. howellii and non-CAM Eleocharis acicularis, Downingja bella, and Plagiobothrys undulatus. Despite wide phylogenetic separation, these species were structurally convergent in that they all produced an aquatic stage with an isoetid species were structurally convergent in that they all produced an aquatic stage with an isocitid growth form. They were functionally similar in that none appeared to utilize bicarbonate, and all were carbon limited through much of the day, as indicated by a marked midday depression in carbon uptake that lasted through the afternoon. All four species were capable of carbon fixation at

night, although only in I. howellii was this accom panied by an overnight accumulation of acid. It was estimated that dark fixation in I. howellii contributed up to 40% of its total carbon gain contributed up to 40% of its total carbon gain under submerged conditions, but was <1% under aerial conditions. The role of dark fixation in the other three non-CAM species is unknown. Short-term steady-state C-14 tracer studies in the laboratory revealed that, under submerged conditions in the light, all species assimilated carbon into C-3 photosynthetic product phosphoglycerate and the C-4 photosynthetic product of malate, citrate, and aspartate. The proportion of label fixed into C-4 organic acids was greatest in E. acicularis. The ratio of ribulose bisphosphate carboxylase/phosphoenol pyruvate carboxylase was broadly similar in all species, ranging from 8.8 to 11.5. Photosynthetic rates and seasonal changes in biomass under thetic rates and seasonal changes in biomass under aerial conditions were also compared. (Medina-PTT) W91-09917

TEMPORAL AND SPATIAL DIVERSITY OF TROPHY-INDICATORS IN A LOWLAND DAM RESERVOIR.

Polish Academy of Sciences, Lomianki. Dept. of

Polish Academy of Scheller, 2018 Academy of

Descriptors: \*Limnology, \*Nitrates, \*Nitrogen, \*Nutrients, \*Phosphorus, \*Poland, \*Reservoirs, \*Trophic level, Ecosystems, Limiting nutrients, Seasonal variation, Secchi disks, Seston, Spatial

The characteristic of hydrological and hydrochemical conditions including estimates of total phosphorus, total nitrogen concentrations and Secchi disc visibility (trophic conditions) in waters of the disc visibility (trophic conditions) in waters of the Zegrzynski dam reservoir in Poland was studied in 1981-1984 to provide a background for a concurrent hydrobiological research, analysis of the reservoir ecosystem, and a basis for evaluating the role of the reservoir in the retention of various substances. Water retention time ranged from 1-20 days with peaks from 5-15 days. Secchi disc greatest visibility values were recorded in the lowest part of the broads and in a small, highly limnetic bay at Zegrze. Visibility values depended mainly on the amount and quality of seston. The greatest amounts of seston were recorded in the Bug river with fairly large amounts noted in the Bug river with fairly large amounts noted in the Narew river. with fairly large amounts noted in the Narew river. The concentration of total phosphorus in water was usually higher in the Bug river than in the Narew river with lowest values in the lower part of the reservoir. Nitrate concentration was affected of the reservoir. Nitrate concentration was affected by water flows and the seasons with highest values recorded in spring and autumn. There was a great diversity and change in values of total nitrogen to total phosphorus ratio for samples collected in 1983 and 1984 which ranged from 2 to 50 with no regular pattern. These values were not indicative of limiting function of shootheart in science. of limiting function of phosphorus in primary pro-duction, as its concentration was always at least several times higher than the limit values. (See W91-09919 thru W91-09925) (Medina-PTT) W91-09918

CHANGES OF THE BUG AND NAREW PHY-TOPLANKTON IN THE ZEGRZYNSKI RESER-

Polish Academy of Sciences, Lomianki. Dept. of Hydrobiology. M. Bubien.

Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 235-250, 1989. 12 fig, 2 tab, 11 ref.

Descriptors: \*Chlorophyta, \*Diatoms, \*Limnology, \*Phytoplankton, \*Plant populations, \*Poland, \*Reservoirs, Biomass, Flow pattern, Population dynamics, Rivers, Sedimentation.

The Zegrzynski reservoir in Poland is the result of an impounding of the Bug and Narew rivers in 1962-1964. It is a relatively small and typically lowland water body, with an impoundment time of several days to about 2 weeks, depending on the discharge rate and stored water volume. A com-

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parison was made of the biomass and dominance structure of the algal communities which input into and output from this reservoir in 1983 and 1984. During this period, there were differences in the During this period, there were differences in the river discharge rates over the growing season, stored-water volumes, and water temperature. In 1984, the algal biomass input into the reservoir was about 1.5 times as high as the input in 1983. The phytoplankton biomass remaining in the reservoir each year represented about 50% of the input algal biomass. In 1983, it was positively correlated with the throughflow volumes, whereas in 1984, it was correlated with the volume of water stored in the reservoir. There were no significant changes in the reservoir. There were no significant changes in the dominance structure of the phytoplankton contained in the water flowing through the reservoir. A storage-time increase and a discharge-rate decrease resulted in a biomass reduction of the diatoms which was greater than that of the green algae found in the water flowing through the reservoir. This may have been due to a slower sedimentation rate of green algae during passage through the broad areas of the reservoir. (See W91-09918 and W91-09929 thru W91-09925) (Medina-PTT) W91-09919

DENSITIES, STRUCTURE AND ROLE OF ZOOPLANKTON IN PHOSPHORUS CYCLING IN LIMNETIC AND LOTIC PARTS OF ZEGR-ZYNSKI RESERVOIR.

Polish Academy of Sciences, Mikolajki. Inst. of Ecology.

Ecology.
J. Ejsmont-Karabin, and T. Weglenska.
Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p
251-280, 1989. 10 fig, 7 tab, 32 ref.

Descriptors: \*Limnology, \*Phosphorus, \*Poland, \*Population dynamics, \*Reservoirs, \*Zooplankton, Crustaceans, Cycling nutrients, Diets, Flow dis-charge, Lotic environment, Predation, Rotifers,

The effect of water flow rate on zooplankton communities and the role of zooplankton in phosphorus cycling in the man-made lake area of this reservoir in Poland was studied in August and September 1982, and in September 1984. Differences in the quantitative and structural features of zooplankton in the limnetic and lotic sites were routed. In the limnetic site, propulsition densities of noted. In the limnetic site, population densities of zooplankton were more unstable with pronounced variations in the densities of rotifers and crusta-ceans, the dominant species. Crustaceans had greater fecundity rates than rotifers and plant food had a greater share in zoonlankton dies. The troops tic zone showed a definite pressure of invertebrate predation on zooplankton which was fairly unsub-stantial in the lotic zone. These two zones also differed in turnover rate of total phosphorus and phosphorus in zooplankton food; lotic zone turnprospinors in Zopiankton root; rote: Zone turn-over time was about 2 times longer than in the limnetic zone indicating more stable food supply in the lotic zone. It is concluded that due to zoo-plankton activity in the limnetic sites of the Zegrzynski Reservoir, phosphorus sedimentation is much lower here than in the lotic site. Structure and zooplankton activity outcome in this type of reservoir is highly influenced by mechanical factors such as the rate of water flow which affects the zooplankton directly (carrying away weak species) or indirectly (predator pressure). (Medina-PTT) W91-09920

DISTRIBUTION AND STRUCTURE OF BENTHOS IN THE LOWLAND ZEGRZYNSKI RESERVOIR

Polish Academy of Sciences, Lomianki. Dept. of Hydrobiology.

K. Dusoge. Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 281-298, 1989. 3 fig, 5 tab, 28 ref.

Descriptors: \*Benthos, \*Limnology, \*Macrophytes, \*Poland, \*Reservoirs, Biomass, Depth, Midges, Oligochaetes, Oxygenation, Phytoplankton, Population dynamics, Water currents, Water pollution effects, Water temperature.

The benthic fauna, its abundance and distribution in the various lake areas of the Zegrzynski Reser-

voir in Poland is presented. The material was collected from 8 different stations in the reservoir May to October 1982 and 1984 using a Kajak type May to October 1982 and 1984 using a Kajak type pneumatic bottom sampler. There was a considerable diversity of bottom fauna observed with Oligochaeta and Chironomidae recorded from all the sampled areas. The greatest number of taxonomic groups were recorded in habitats located close to the shore and from the bay partly separated from the reservoir. The least number of specimens were recorded (only Oligochaeta and Chironomidae) from sandy bottom habitats with strong currents. The high faunal density and biomass in the reservoir broads (up to 700 g/sq m) could possibly be due to favorable trophic conditions in this type of habitat. The Bug river, which is one of the rivers that feeds into the reservoir, carries large amounts of phytoplankton that decay and settle providing a that reeds into the reservoir, carries large amounts of phytoplankton that decay and settle providing a nutritive food supply for Chironomus plumosus larvae and Oligochaeta. Relatively high water temperatures and oxygenation during the vegetative season due to the shallowness of the reservoir season due to the shallowness of the reservoir favor the development of bottom fauna. However, periods of oxygen deficit following pollution of the reservoir with organic sewage would undoubtedly result in mass mortality and decomposition of the benthos and deterioration of the quality of water in the reservoir. (See W91-09918 thru W91-09920 and W91-09922 thru W91-09925) (Medina-PTT)

ZOOBENTHOS COMMUNITIES OF NEAR-SHORE ZONE IN THE ZEGRZYNSKI RESER-

Akademia Rolniczo-Techniczna, Olsztyn-Kortow B. Kuklinska.

Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 299-318, 1989. 1 fig, 7 tab, 25 ref.

Descriptors: \*Benthos, \*Limnology, \*Macroinver-tebrates, \*Poland, \*Reservoirs, Biomass, Midges, Oligochaeta, Population density, Predation, Sub-

Population density, biomass and taxonomic structure of the zoobenthos in the near-shore bottom zones of the fishing grounds of this reservoir in zones of the fishing grounds of this reservoir in Poland were compared. Samples were collected with a tubular bottom sampler at one-month intervals in 1986-1988. The biomass of the bottom zoo-cenoses was composed mainly of mollusks especially in the 1-2 m zone of the Bug River and in the expansion zone of the reservoir. Other common bottom fauna included Oligochaeta and Chironomidae which increased in density as the depth increased in the 0.2-2.0 m near-shore zone of the Bug River. Lower levels of zoobenthos with similar taxonomic structure, mainly Chironomidae and Oligochaeta, were recorded in the expansion zone of the reservoir and in its narrowest part below Zegrze. The least number of zoobenthos were recorded on the near-shore zone of the Narew River, where the dominant group was Oligochaeta, and predatory larvae of the chironomid genera Procladius and Tanypus. The differences observed in species abundance and structure of the zoobenthos species abundance and structure of the zoobenthos from the different sampling sites may be due to differences in the type of substrata: sandy bottom with detritus and loose-silt layer, clayey substratum with 10-20 cm mud-layer, sandy sediments with underwater vegetation, and sand-covered bottom with a thin (about 3 cm) silt layer. (See W91-09918 thru W91-09921 and W91-09923 thru W91-09925) (Medina-PTT) W91-09922

OCCURRENCE OF MOLLUSCS IN THE LITTORAL ZONE OF THE ZEGRZYNSKI RESERVOIR AND IN THE PRE-MOUTH AND MOUTH ZONES OF SUPPLYING RIVERS.

MOUTH ZONES OF SUPPLYING RIVERS.
Polish Academy of Sciences, Lomianki. Dept. of
Hydrobiology.
E. Jurkiewicz-Karnkowska.
Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p
319-336, 1989. 3 fig, 5 tab, 43 ref.

Descriptors: \*Limnology, \*Mollusks, \*Poland, \*Reservoirs, \*Stream biota, Aquatic habitats, Biomass, Freshwater mussels, Littoral zone, Macrophytes, Population density, Seasonal Species composition.

Species composition, abundance and dominance of mollusks in the littoral zone of the Zegrzynski Reservoir (Poland) and in the pre-mouth and mouth zones of supplying rivers were studied in 1980 and 1981 and compared with those of other 1980 and 1981 and compared with those of other dam reservoirs and the rivers supplying them. Data were collected from three habitats: rivers, mouth of rivers, and the reservoir. There were 49 species of mollusks recorded (19 Pulmonatta, 8 Prosobranchia and 22 Bivalvia). The highest density was observed in the mouth of rivers, slightly lower in river habitats, and least in the reservoir. Mollusk density, and homass were much higher in 1981. density and biomass were much higher in 1981 than in 1980. Bottom samples yielded greater num-bers and biomass than those taken from high con-centrations of macrophytes. Seasonal changes in centrations of macrophytes. Seasonal changes in abundance did not show a regular pattern. In all three types of habitat, mussels of the genus Pisidium was the most abundant. Lithoglyphus naticoides dominated in rivers, Valvata piscinalis and Lymnaea in river mouth zones and Viviparus viviparus in the reservoir (also Dreissena polymorpha in 1981). (See W91-09918 thru W91-09922 and W91-09924 and W91-09925) (Medina-PTT) W91-09923

OCCURRENCE OF VIVIPARUS VIVIPARUS (L.) IN THE ZEGRZYNSKI RESERVOIR,

Polish Academy of Sciences, Lomianki. Dept. of

Hydrobiology. K. Lewandowski, T. Graczyk, and A. Stanczykowska.

Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 337-346, 1989. 4 fig, 1 tab, 13 ref.

Descriptors: \*Limnology, \*Mollusks, \*Poland, \*Reservoirs, \*Snails, Biomass, Distribution patterns, Drift, Mortality, Parasitism, Population den-

In June 1983, the occurrence and distribution of V. viviparus in the Zegrzynski Reservoir (Poland) viviparus in the Zegrzynski Reservoir (Poland) were studied. Distribution was uneven with high population densities of 3000 specimens/sq m and wet biomass of 3.3 kg/sq m. These were recorded at a depth of 6 m in the Narew river backwater. Most of the specimens observed were young with body length less than 12 mm. They accounted for 90% of the population in shallow areas and 50% in the deeper areas. A large number of dead specimens and empty shells were found in the shores and at the bottom of many stations in the reservoir. d at the bottom of many stations in the reservoir. Notable differences in population density were found in the stations where the observations were made. Dead specimens and empty shell accumulamade. Dead specimens and empty sheil accumula-tion in certain areas of the reservoir were most likely the result of drift by wind and currents. This seemingly mass mortality is attributed to natural causes of overpopulation and not parasitism, since parasitic analysis conducted on live samples of different sizes from stations with high density, low density and in areas with empty shells proved negative for trematode cercaria, the most common parasite of this mollusk. (See W91-09918 thru W91-09923 and W91-09925) (Medina-PTT)

ACCUMULATION OF ZINC AND COPPER IN MOLLUSCS FROM THE ZEGRZYNSKI RESERVOIR AND THE NAREW RIVER.

Polish Academy of Sciences, Lomianki. Dept. of

Hydrobiology. E. Jurkiewicz-Karnkowska. Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 347-357, 1989. 2 fig, 2 tab, 38 ref.

Descriptors: \*Bioaccumulation, \*Copper, \*Mollusks, \*Path of pollutants, \*Poland, \*Reservoirs, \*Zinc, Bioindicators, Biomass, Clams, Freshwater Snails, Spectrometry, Tissue analysis,

Zn and Cu contents in soft tissues and shells of Viviparus viviparus, Lymnaea spp., Dreissena polymorpha and Pisidium spp., the most common species of mollusks in the Zegrzynski Reservoir (Poland), were analyzed by atomic absorption spectrometry. Cu concentrations in soft tissues ranged between 13 and 123 microgram/g dry weight and Zn concentrations were between 33

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and 350 micrograms/g dry weight. Generally, these values are several tens of thousands higher than the natural Cu and Zn concentrations in water. Cu and Zn contents in V. viviparus and D. polymorpha shells were lower than in soft tissues of these mollusks. Zn and Cu concentrations in the soft tissues of V. viviparus and Lymnaea spp. in the Nature vices were consently higher than socrasoft insues of V. Aviparus and Lymnaca spp. in the Narew river were generally higher than corresponding values in the reservoir. This is possibly due to the partial purification of the inflowing water by the group of mollusks living in the section near and in the mouth of the Narew river. The high biomass of mollusks in many areas of the servoir could result in the accumulation of considerable amounts of metals by these animals which suceratie amounts of metats by these animals which would contribute to the threat of secondary pollution of the aquatic environment brought about by higher mortality of the mollusks. V. viviparus would probably serve as an excellent indicator of pollution in the Zegrzynski Reservoir. (See W91-09918 thru W91-09924) (Medina-PTT) W91-09925

HYDROBIOLOGICAL CHARACTERISTIC OF THE LOWLAND, RHEOLIMNIC WLOCLAWEK RESERVOIR IN THE VISTULA

Nicholas Copernicus Univ. of Torun (Poland). Nicholas Copernicus Univ. of Torun (Foliandy). Dept. of Hydrobiology. A. Gizinski, L. A. Bledzki, A. Kentzer, R. Wisniewski, and R. Zytkowicz. Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p 359-403, 1989. 8 fig, 15 tab, 65 ref.

Descriptors: \*Eutrophication, \*Hydrobiology, \*Limnology, \*Nutrients, \*Poland, \*Reservoirs, \*Water pollution sources, \*Zooplankton, Benthic fauna, Dissolved oxygen, Hypertrophic lakes, Littoral zone, Midges, Mollusks, Oligochaeta, Water chemistry.

The Wloclawek reservoir in Poland, constructed in 1969-1970, is the only reservoir on the lower Vistula and is highly polluted. In 1980-1984, its hydrochemistry, plankton (primarily zooplankton) and macrozoobenthos were studied. Water analysis showed especially high concentrations of nutrients (P and N) and the prevalence of ammonium in the form of mineral nitrogen which indicates hypertrophy. The examined parameters were highly variable and this variability was attributed primarily to irregular flows which cause resuspension of bottom sediments with a pronounced effect on the oxygen regime of the reservoir. A transverse pro-file defines two zones: the current and littoral zone. Oxygen conditions in the depths of the littoral broads were poorer than those in the current zone. Species composition of plankton and zoobenthos of the two zones was similar. Vertical stratification of the chemical constituents and zooplankton was not observed except for oxygen content which de-creased in the water directly above the sediments. Increased retention time was noted with more definite indicators of trophy, quantitative growth of zooplankton and a distinct increase in abundance of zoobenthos in the reservoir, particularly Oligoof zoobentnos in the reservoir, particularly Oligo-chaeta, Mollusca and Chironomidae. These obser-vations indicate the variability of the abiotic and biological features of the Wloclawek Reservoir. (Medina-PTT) W91-09926

WATER QUALITY CLASSIFICATION OF THE VISTULA RIVER BASIN IN 1987. Institute of Meteorology and Water Management, Warsaw (Poland). Dept. of Water Chemistry. For primary bibliographic entry see Field 5B. W91-09927.

TROPHIC STATUS AND NUTRIENT CONCENTRATIONS OF CENTER HILL LAKE 1988.

Tennessee Technological Univ., Cookeville. S. J. Pucker, and J. A. Gordon. Journal of the Tennessee Academy of Science JTASAG, Vol. 46, No. 2, p 73-78, 1991. 1 fig, 10 tab, 10 ref.

Descriptors: \*Limnology, \*Tennessee, \*Reservoirs, \*Mesotrophic lakes, \*Nutrient concentrations, Hydroelectric plants, Flood control, Phos-

phorus, Anoxic conditions, Bays, Water quality

The collection and subsequent analysis of embayment and main channel data over an 11-month period for Center Hill Lake, a 40-year old U.S. Army Corps of Engineers reservoir constructed for flood control and hydroelectric power produc-tion in Middle Tennessee, indicates that the overall water quality has improved significantly over the past ten years. From the physical and chemical (nutrient) characterization of the Caney Fork River Basin it was concluded that: (1) the main River Basin it was concluded that: (1) the main portion of Center Hill Lake is low in essential nutrients and is usually phosphorus limited based on N.P ratios; however, late spring appeared to be the only time that the lake was not phosphorus limited. (2) embayments had higher concentrations of the essential nutrients and phosphorus was more abundant in the metalimnion and hypolimnion; (3) dissolved oxygen values are much lower in the metalimnion and hypolimnion in the embayments, and are well below concentrations required by aerobic organisms, such as fish, at all depths below the epilimnion in the embayments, and (4) the main lake portion of Center Hill Lake has good dissolved oxygen concentrations except for a pronounced zone of low DO termed the metalimnetic minimum. (Author's abstract) W91-09932

OBSERVATIONS ON THE DRAINAGE OF AN ICE-DAMMED LAKE IN WEST GREENLAND. Aberdeen Univ. (Scotland). Dept. of Geography. For primary bibliographic entry see Field 2C. W91-09944

DEMOGRAPHY AND ECOLOGICAL IMPACTS OF THE INVADING MOLLUSC DREIS-SENA POLYMORPHA. Windsor Univ. (Ontario). Great Lakes Inst.

P. D. N. Hebert, C. C. Wilson, M. H. Murdoch, and R. Lazar.

Canadian Journal of Zoology CJZOAG, Vol. 69, No. 2, p 405-409, February 1991. 6 fig, 12 ref.

Descriptors: \*Bivalves, \*Ecological effects, Freshwater mussels, \*Introduced species, \*Lake ecology, \*Limnology, \*Mollusks, \*Population dynamics, Canada, Colonization, Lake St Clair, Population density, Turbidity.

The bivalve mollusk Dreissena polymorpha colonized Lake St. Clair (Ontario, Canada) in 1986 as a result of ballast water discharge. Since initiating reproduction in 1988, its population density at all of the sites originally colonized has increased more than 1000-fold. The species has also expanded its range in Lake St. Clair dramatically. The density and range increase is not yet complete, as popula-tions at most sites remain dominated by juveniles. Densities in excess of 5000 individuals/sq m seem likely to be achieved at most sites within 5 years. D. polymorpha will probably have a significant impact on composition of the benthos. Shells of individual unionids carry in excess of 10,000 D. polymorpha, and lipid reserves of such unionids polymorpha, and lipid reserves of such unionids are only half those of unaffected individuals. Aside are only had those of unaffected individuals. Aside from direct interactions with benthic organisms, the filtering activity of D. polymorpha populations may be sufficient to result in a significant impact on the turbidity of water exiting Lake St. Clair. (Author's abstract) W91-09951

COMPARISON OF ESTIMATES OF PRODUCTIVITY AND CONSUMPTION BY ZOO-PLANKTON FOR PLANKTONIC CILIATES IN LAKE ONTARIO.

Waterloo Univ. (Ontario). Dept. of Biology. W. D. Taylor, and O. E. Johannsson.

Journal of Plankton Research JPLRD9, Vol. 13,
No. 2, p 363-372, March 1991. 4 fig, 24 ref.

Descriptors: \*Aquatic productivity, \*Lake Ontario, \*Lake ecology, \*Limnology, \*Primary productivity, \*Protozoa, \*Zooplankton, Biomass, Carbon cycle, Epilimnion, Food chains, Predation, Regres-

A multiple regression equation predicting growth rate for ciliates from cell size and temperature was combined with measurements of biomass to esticombined with measurements of biomass to estimate the productivity of ciliates in the epilimnion of Lake Ontario. This method predicts daily production to biomass values for ciliates of up to 5/day and leads to the conclusion that ciliate production could equal half of the carbon fixation by phototrophs. Consumption of ciliates by metazoan contaction was estimated by incubating camples zooplankton was estimated by incubating samples passed through 44 micron screens, and determining the increase in abundance of ciliates over 24 h. These rates are much lower, <1/day and often near zero. Production estimates based on these latter rates would be about 3-4% of primary prolatter rates would be about 3-4% of primary production. Possible explanations for this discrepancy include both predation within the microzooplankton community and food limitation, as well as bottle effects. However, the lower production estimates are still compatible with ciliates playing a major role in this ecosystem. (Author's abstract) W91-09955

ALGAL CARBON-NITROGEN METABOLISM: A BIOCHEMICAL BASIS FOR MODELLING THE INTERACTIONS BETWEEN NITRATE AND AMMONIUM UPTAKE.

Dunstaffnage Marine Research Lab., Oban (Scotland).

For primary bibliographic entry see Field 2L. W91-09956

FACTORS CONTROLLING THE EVOLUTION OF SALINITY, PRODUCTIVITY AND ECOLOGICAL STABILITY OF EUTROPHIC LAKES IN CENTRAL NORTH AMERICA (A SUMMARY).

National Water Research Inst., Burlington (Ontar-io). Lakes Research Branch.

J. Barica.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 9-14, 1990. 3 fig,

Descriptors: \*Eutrophic lakes, \*Limnology, \*Manitoba, \*Phytoplankton, \*Primary productivity, \*Salinity, Biomass, Canada, Chlorophyll a, Climatology, Groundwater movement, Groundwater quality, Ions, Lake ecology, Lake morphometry, Soil types, Summerkill, Topography.

The variability in ionic composition, phytoplank-ton, biomass, production and ecological stability of a group of over 100 small, shallow and moderately saline lakes in southwestern Manitoba, Canada was investigated. A wide variation was observed in the cific conductance, summer chlorophyll a levels, specine conductance, summer entoropyin a tevery, and concentration range of ions. Highly eutrophic lakes posing high summerkill risk were evenly distributed across the study area. Several potential factors contributed to the formation of salinity and primary productivity: (1) Surface deposits and soils--the distribution of lakes appears to be generally random and independent of major soil types and surface deposits, (2) Topographic relief-the salinity varies considerably regardless of the general slope, with highly saline lakes concentrated in the middle of the regressing profile and low salinity lakes located at both higher and lower elevations; (3) Groundwater-observed ranges in groundwater salinity agree with the adjacent lakes in only about 30% of all cases and the rest deviate from them randomly; (4) Lake morphometry-while it was expected that small lakes would be more saline and more eutrophic than large ones, investigations of mean depth, volume, and drainage and concentration range of ions. Highly eutrophic investigations of mean depth, volume, and drainage area failed to confirm this assumption; (5) Semiarid climate--air pressure, wind velocity, precipita-tion and rate of surface runoff affect the relative water loss, resulting in a gain in the total dissolved solids; (6) Groundwater flow-within the overall regional flow, there are many local and intermediate flows which carry water and dissolved solids ate now which carry water and dissolved solids from one lake to another without any uniform pattern. This explains why one lake can differ substantially from another within a short distance, and why the lakes do not show any considerable groupings as would be expected if only regional flow existed. Groundwater flow also affects the variability in chlorophyll a. Nutrient input varies

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as a result of different land use management pracas a result of different land use management prac-tices in the study area. The elevated salinity of prairie lakes is apparently produced primarily by semi-arid climatic conditions, and the development of lake water chemistry depends on local hydrographic and hydrologic conditions. (Sand-PTT) W91-09976

## CAN BACTERIA AFFECT THE PHYTOPLANK-TON SUCCESSION IN LACUSTRINE ENVI-RONMENTS.

Warsaw Univ. (Poland). Dept. of Environmental Microbiology. R. J. Chrosi

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 15-20, 1990. 22 ref.

Descriptors: \*Lacustrine environment, \*Lake ecology, \*Limnology, \*Phytoplankton, \*Succession, Algae, Aquatic bacteria, Carbon, Cycling nutrients, Dissolved solids, Eutrophication, Light effects, Nitrogen, Phosphorus.

Trophic relationships between heterotrophic bacteria and algae in the phosphorus, nitrogen, and carbon cycles can potentially play a role in the phytoplankton succession in lacustrine environ-ments. Bacteria, together with protozoans and ciliates, create a microbial loop in the ecosystem, the major step in this process is the conversion of dissolved organic matter into bacterial biomass and production; this can constitute 40-60% of phytoproduction; this can constitute 40-60% of phyto-plankton primary production. Heterotrophic bacte-ria have a very high efficiency of organic matter utilization, and one of the highest respiratory po-tentials for organic matter oxidation. This facili-tates the released CO2, PO4(3-), NH4(+), and tates the federace CO2, FO9(3-), NH(+), and other nutrients required for phytoplankton metabolism. The microbial loop therefore contributes to the steady supply of algal nutrients and promotes a steady state of algal biomass and production in the steady state of aigal blomass and production in the absence of other sources and nutrients. There are several potential consequences of phytoplankton nutrient enrichment due to bacterial activity. Once the phytoplankton have built up a large population, they or their propagules assume a leading position in the subsequent time period and actually deserged by the decides the growth of competitors. position in the subsequent time period and actually depress, by shading, the growth of competitors. Since many of the favored fast-growing species are also small, they will presumably increase the potential food supply for zooplankton. As eutrophication advances and biological production increases, more biogenic material falls to the lake bottom, which becomes totally anoxic. The maintenance of larger suspended stocks of phytoplankton and particulate detritus reduces light penetration, biasing the outcome of interspecific competition in favor of shade species. Enrichment of P or N supplies by bacterial regeneration activity may stress the light of shade species. Eithermient of Pol N supplies by bacterial regeneration activity may stress the light resources of a lake, and those of other nutrients that were previously saturating the requirements of algal growth. (Sand-PTT) W91-09977

## OLIGOTROPHICATION, LAKE DEVELOP-MENT ALONG WITH ACIDIFICATION.

Helsinki Univ. (Finland). Dept. of Limnology. . Eloranta.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 21-25, 1990. 1 fig,

Descriptors: "Acid rain, "Acid rain effects, "Environmental effects, "Lake acidification, "Limnology, "Oligotrophic lakes, "Phytoplankton, Carbon compounds, Carbonates, Crustaceans, Daphnia, Epilimnion, Humic substances, Hydrogen ion concentration, Metals, Nutrients, Oxygen depletion, Phosphates, Photosynthesis, Primary productivity, Silicates, Solar radiation, Water chemistry, Water temperature, Zooplankton.

Lake acidification, with the resultant decrease of water pH, is followed by some positive and nega-tive factors for phytoplankton. Many larger her-bivorous crustaceans like Daphnia disappear, caus-ing a decrease in both grazing pressure and excretion of nutrients by zooplankton. The thickness of the eutrophic layer increases with the precipitation of humic matter, also resulting in a more effective primary production. The clearing up of the water

also increases the thickness of the epilimnion. With also increases the infections of the epiminion. What the solar radiation heating a larger water volume, the average water temperature of the eutrophic layer stays lower than in dark brown lakes. This lowers the photosynthetic activity but also decreases the sedimentation rate due to the higher density and viscosity of the cooler water. Negative changes from lake acidification are associated mostly with changes in water chemistry. One of the major changes is the reduction of the inorganic C concentration, particularly bicarbonates. The increasing acidity also causes an increase in the concentration of dissolved metals (Al, Zn, Cu, Mn), which has direct, toxic effect on algae. These metals also react with nutrients, such as phosphates and silicates, reducing the nutrient concentration simultaneously with the precipitation of humic substances. The sedimentation of allochthonous organatter decreases the oxygen consumption in the hypolimnion; thus, the hypolimnetic oxygen deple-tion is less obvious and the nutrient release from the sediment is lower than nutrient sedimentation. the sediment is lower than nutrient sedimentation. Changes in physical factors like light penetration, thermal stratification and water viscosity, which are secondary results of acidification associated with the precipitation of humic compounds, may play only a minor role in the environmental changes affecting phytoplankton during acidifica-tion. Low species richness is also typical in acidic waters, as a result of low nutrient concentrations (P and N), metal toxicity, and the lack of carbonates and free reactive silica at low pH. (Sand-PTT)

## INFLUENCE OF SOME NATURAL AND AN-THROPOGENIC FACTORS ON THE RATE OF LAKE EUTROPHICATION.

Institute of Physical Planning and Municipal Economy, Drzymaly 24, 60-613 Poznan, Poland. R. Goldyn, and M. Stempnias Uniwersyste Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 26-31, 1990. 3 tab, 3 cef

Descriptors: \*Agricultural runoff, \*Environmental effects, \*Eutrophication, \*Lakes, \*Limnology, Agriculture, Drainage area, Epilimnion, Eutrophic lakes, Lake morphology, Land use, Poland, Stratification, Water quality.

A group of 20 lakes situated within the Miedzychod-Sierakow lakeland in Poland, were investi-gated to establish the role of natural and anthropogated to establish the role of natural and antirropo-genic factors in the development of temperate cli-mate lowland lakes. The trophic state index was the basis for evaluating the influence of several factors on the rate of eutrophication. These factors are described by 8 coefficients: (1) the Schindler are described by a coefficients: (1) the Schmidter coefficient, expressed by the ratio of the sum of the drainage area (S-d) and lake surface (S-1) to lake volume (V-1); (2) the percentage share of agriculture (S-a) and build-up area (S-b) in S-d diminished by S-1; (3) the ratio of the sum of S-a and S-b to Vby S-1; (3) the ratio of the sum of S-a and S-b to V-1; (4) the ratio of the area of mineral to organic soils; (5) the average depth of the lake (V-1/S-1); (6) the ratio of the area of active bottom to the epilimnion volume; (7) the percentage of water stratification, expressed by the share of hypolimnion in V-1, and (8) the ratio of V-1 to the length of the shore line. The most important factor influencing the trophic state of the lakes appeared to be the size of the drainage area (including the agriculture and built-up areas) falling to the unit of the lake volume. Only in certain cases was the trophic state related to the percent share of fields and built-state related to the percent share of fields and builtstate related to the percent share of fields and built-up areas in the drainage basin and to the ratio of mineral and organic soils. A comparison of the coefficients of management of the drainage area coefficients of management of the drainage area showed that the percent share of fields and built-up terrains in the drainage area had little effect on the progress of eutrophication. The most important internal factor preventing a rapid eutrophication rate is a great lake depth with a rather small bottom surface in contact with epilimnion waters. An important factor in slowing down eutrophication is lake volume in relation to the length of the shore line. This factor is not important in cases where the shore line is in contact with forests for a where the shore line is in contact with forests for a considerable part of its length. The least important factor contributing to the internal protective bar-rier of the lakes is the shore of hypolimnion, ex-pressed by the coefficient of the percentage of stratification. (Sand-PTT)

W91-09979

## ALGAL CHANGES DURING THE HOLOCENE: RECORDS FROM A MARITIME, MONTANE REGION IN BRITAIN.

Freshwater Biological Association, Ambleside (England).

E. Y. Haworth.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 32-36, 1990. 2 fig, 1 tab, 12 ref.

Descriptors: \*Algae, \*Diatoms, \*England, \*Lake ecology, \*Limnology, \*Paleolimnology, \*Species composition, Asterionella, Cyclotella, Fragilaria, Glacial lakes, Holocene Epoch, Lake sediments, Nutrients, Species diversity

In the English Lake District of Britain, the lakes can be divided into several groups according to their evolution: those whose development dates from the retreat of the main, Full Glacial ice and was checked by the final, Loch Lomond/Younger Dryas cold stadial, and those whose basins were reoccupied by glaciers of the last stadial, and where development dates from the early Holocene. The concentration of the alga Pediastrum increases along with the carbon percentage when diatoms are rare and few in species. Many Chryso-phycean cysts are seen throughout the sediment record. An abrupt lithostratographic change from glacial clays to organic clay-silt is immediately accompanied by an increase in diatom abundance and diversity, around 10,000 BP. Most early postglacial lakes were of the alkaline type, according to the ecological distribution of diatoms, such as to the ecological distribution of diatoms, such as Fragilaria, Aulacoseirta and Epithemia. Plankton diatoms are dominant from the earliest post-glacial periods. In general, the Fragilaria horizons were succeeded by Aulacoseira, Cyclotella, Stephanodiscus and Asterionella, as the carbon percentage rose during Boreal time. Cyclotella plankton became dominant during the Allantic or Subboreal when many alkaline diatoms were replaced by circumneutral forms. Despite geographic differences, Lake District records for the early Holocene include a similar succession to that found in Scandinavian lakes which have evolved from the sea as land levels rose. Plankton is used as an index of lake level changes in continental lakes. In this context, a constant 70% plankton in Ullswater illustrates how little minor changes in water level can affect these long deep lakes. Correlation with pollen and geochemical analysis shows that upper Holocene plankton was determined mainly by catchment perturbations due to agriculture and, in reducence plantshow was determined manny by catchment perturbations due to agriculture and, in the lowlands, to increased nutrients from fertilizers or sewage outfalls encouraging eutrophic diatoms. Upland lakes of impoverished grassland have remained oligotrophic. (Sand-PTT) wol.000801

## INVESTIGATION OF THE LAKES AS THE RELATIVELY STABLE ECOSYSTEMS, A THE-ORETICAL APPROACH.

Adam Mickiewicz Univ., Poznan (Poland). Dept. of Philosophy K. Lastowski.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 37-44, 1990. 9 ref.

Descriptors: \*Ecosystems, \*Lake ecology, \*Lim-nology, \*Theoretical analysis, Lake morphology, Model studies, Nitrogen, Nutrients, Phosphorus, Productivity

A theoretical analysis is made of ecological relations occurring in a lake, upon the assumption that the ecological evolution of a lake is chiefly determined by the proportion of nitrogen to phosphorus. This assumption is supported by the fact that both N and P function as limiting factors all ecological processes possible within the lake. This fact can be expressed by two statements: (1) If the concentration of N or P in the ecosystem exceeds optimum values which determine the proportion of N and P for a given lake, then the lake ceases to be a stable ecosystem over a comparatively short period of time; and (2) If the concentration of N or P within a lake ecosystem falls below a certain

critical value of the N:P ratio established for a given lake, then the lake ceases to be an ecological system. It becomes, in a comparatively short period of time, a system in which transbiotic relations are absent. Both statements present the activity of abiogenic factors and biogenic dependencies, with a decomposity of the This relation expectation. tions are absent. Both statements present the activi-ty of abiogenic factors and biogenic dependencies, with a close relation to time. This relation ex-pressed, for example, in a systematic or temporal (fluctuational) activity of specified ecological de-pendencies, often leads to significant (irreversible) change with ecosystems cares where the duration of ecological dependency leads to the modification of ecosystems further confirms this fact. (Sand-PTT W91-09981

RECENT TROPHIC CHANGES AND PHYTO-PLANKTON COMPOSITION IN LAKE DRUM-MOND, WITHIN THE DISMAL SWAMP, VIR-GINIA.
Old Dominion Univ., Norfolk, VA. Dept. of Bio-

logical Sciences H. G. Marshall.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 45-49, 1990. 5 ref.

Descriptors: \*Dismal Swamp, \*Ecological effects, \*Lake Drummond, \*Lake ecology, \*Limnology, \*Oligotrophy, \*Phytoplankton, \*Trophic level, \*Virginia, Acidic water, Agricultural runoff, Asterionella, Chlorophyta, Cyanophyta, Cyclotella, Desmids, Diatoms, Euglenophyta, Hydrogen ion concentration, Melosira, Nutrients, Scenedesmus, Seasonal variation, Species composition, Species diversity, Water conservation.

Phytoplankton assemblages from Lake Drummond have been monitored for the past 20 years. During the 1970's the phytoplankton was dominated by the diatoms Asterionella formosa, Melosira herzogii and the desmids Closterium gracile, Stauras-trum paradoxum and Scenedesmus opoliensis. Over the past decade, there has been a diminishing and sporadic appearance of M. granulata, M. her-zogii, and A. ralfsii; both M. herzogii and A. ralfsii were associated with increased rainfall and drainage into the lake, and an accompanying increase in pH. A study of phytoplankton assemblages from pH. A study of phytoplankton assemblages from Dec. 1988 to Nov. 1989 indicated a continued dominance of diatoms, chlorophytes and crypto-monads. Maximum growth occurred in winter, decreasing into the summer and fall. Chlorophytes were dominant in early winter and summer. while were dominant in early winter and summer, while cryptomonads, euglenoids, chrysophytes, cyanobacteria and a picoplankton component were most abundant in summer. Data from 1970 indicates specific shifts in the phytoplankton assemblages and several water quality values. In addition to the reduction of M. herzogii, M. granulata and A. ralfsii, the desmid populations declined dramatically over this period. Other changes noted were an increase in the chlorophyte-desmid ratio, a decrease in the pennate-centric diatoms, and an increase in Cyclotella spp. Although there are few past data on water quality in Lake Drummond, there is a pattern of slightly elevated pH and reduced nutrient levels. These trends indicate a change to a more oligotrophic status, and be the result of recent managerial practices. Past drainage practices in the swamp have reduced water entry to the lake from swamp sections rich in peat deposto the lake from swamp sections rich in peat deposits and areas exposed to agricultural runoff, reducing the amount of nutrients and acidic water enter-ing the lake. This action and other water conservation methods would also direct nutrients that previously entered the lake to be other areas within the swamp, increasing the resident time for water to the lake. (Sand-PTT) W91-09982

VALORIZATION OF BIOINDICATION OF FOSSIL DIATOM IN BOTTOM SEDIMENTS OF THE LEDNICA LAKE,

Adam Mickiewicz Univ., Poznan (Poland). Dept. of Hydrobiology. K. Piescikowski.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 50-55, 1990. 13 ref.

Descriptors: \*Bioindicators, \*Bottom sediments, \*Diatoms, \*Lake ecology, \*Lednica Lake, \*Oligo-

trophy, \*Paleolimnology, \*Poland, \*Trophic level, Cyclotella, Fragilaria, Lake morphology, Melosira, Navicula, Shannon index, Species composition, Species diversity, Tabellaria.

Trophic indexes were used for the reconstruction of the history of trophic conditions of Lednica Lake in Poland. Two of these indexes are based exclusively on the quantitative relationship beexclusively on the quantitative relationship between specific taxonomic groups of diatoms—the Centrales:Pennales and Araphidales:Centrales ratio. A third index is that of biocenotic differentiation calculated according to the Shannon equation—the Shannon index. The diatom bioindicators Cevelotella compts, a taxon characteristic for oligoneral compts. Cyclotella comta, a taxon characteristic for oligotrophy, and Stephanodiscus astraea, associated with high trophy, did not occur (or appeared only in small numbers) in the oldest sedim nts. Over a in small numbers) in the oldest sediments. Over a period of time, associated with a rise in the water level, they appeared in a number of samples, often constituting the quantitative majority of the diatom flora. The large share of taxons preferring high trophy in the early stages of lake development may be accounted for by the relatively high fertility of waters during this period; a result of a bottom zone rich in biogenes of non-organic origin. The numerous presence of Melosira granulata and M. islandica in the youngest sediments of the lake, associated with the fertilized waters, also indicates the increasing trophy of lake waters; result of the anthropogenic influence in recent years. Tabellaria flocculosa and T. fenestrata, taxons characteristic of oligotrophy and mesotrophy associated with the littoral zone, occurred in both cores in great numhttoral zone, occurred in oon cores in great num-bers. Their presence was probably related to the period of redesigning of the Cyclotella-Stephano-discus flora into the Melosira-Fragilaria-Asterion-ella flora, during which there could even exist a periodic stabilization of the lake trophy. Opephora and Fragilaria, taxons associated with waters of high trophy, occurred in the whole section of both night trophy, occurred in the whole secund of both cores in small amounts taking into consideration the specific taxons, but were encountered together in great amounts. The benthic diatom Navicula scutelloides occurred on all levels of both sediment cores. Based on the Shannon index and diatom bioindicators, Lednica Lake may be described as a reservoir of relatively stable trophic conditions over the course of history. (Sand-PTT) W91-09983

CAUSES OF CHANGES IN THE COMMUNITIES OF ALGAE IN POLAND.
Polish Academy of Sciences, Krakow. Inst. of

Botany.

For primary bibliographic entry see Field 5C. W91-09985

CHANGES IN THE PHYTOPLANKTON IN THE HYPERTROPHIC LAKE WITHIN THE COMPASS OF ELEVEN YEARS.

Adam Mickiewicz Univ., Poznan (Poland). Dept. of Hydrobiology.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 74-79, 1990. 1 tab,

Descriptors: \*Algal blooms, \*Hypertrophic lakes, \*Lake ecology, \*Limnology, \*Phytoplankton, \*Reservoirs, Aphanizomenon, Ceratophyllum, Chlorophyta, Cyanophyta, Diatoms, Jelonek Lake, Nitrogen compounds, Phosphorus compounds, Poland, Seasonal variation, Species composition,

Changes in the abiotic conditions and biotic structure of phytoplankton in Jelonek Lake in Poland during 1977-88 were investigated. During the summer months there was an increased trophy compared to the spring, manifested by a distinct increase in total-P concentrations. There was also a predominance of unreduced compounds, mainly N in the form of ammonium. An important factor which may have inhibited the mineralization of N compounds could be the severe oxygen deficits which persisted during part of the year. In spite of the great taxonomic differentiation of phytoplank-ton, only a few species achieved a high frequency: cryptophytes, diatoms, blue-green and green algae. The number and biomass of phytoplankton exhibited large seasonal variations. The most intensive development occurred in the summer. The biomass in the spring and winter phytoplankton was small since the quantitative dominance during these sea-sons was by nanoplankton forms. The phytoplankton did not show seasonal succession typical of eutrophic reservoirs in which the spring maximum is formed by diatoms, whereas the share of bluegreen algae grows in summer. During 1977-88 two different stages of phenomena were observed: the 1st stage, from 1977-84, was characterized by great Ist stage, from 1977-84, was characterized by great stability in the summer phytoplankton associations, a significant feature being the one-species blooms of Aphanizomenon flos-aquae recurring annually. The second stage began a mass appearance of the submerged macrophyte Ceratophyllum demersum in the summer of 1986. At that time this plant covered the whole bowl of the lake; in 1987 its share in the reservoir was insignificant. The decrease in the reservoir was insignificant. crease in the macrophyte biomass in the follow years was accompanied by an increase in the lake trophy of the phytoplankton biomass. The taxonomic structure of phytoplankton was also reconstructed. The summer of 1989 exhibited a renewed strengthening of the domination of one-species Aphanizomenon blooms and the return to the 1977-84 situation. The change in the abiotic and biotic conditions caused by the presence of macrophytes seems to be an unstable, transitory system, and one which resists the successive increases of trophy of the reservoir. (Sand-PTT) W91-09987

TRENDS OF LAKE TROPHY EVOLUTION DUE TO ALLOCHTHONOUS HUMIC SUBSTANCES.

Akademia Rolnicza, Lublin (Poland). . Wojciechowski.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 87-89, 1990. 7 ref.

Descriptors: \*Dystrophic lakes, \*Eutrophic lakes, \*Humic acids, \*Lake ecology, \*Limnology, \*Peat bogs, \*Trophic level, Humic substances, Mineral-

Humification of organic matter occurring in ombrophilous peat bogs and soils of coniferous forests leads to an accumulation of humic acids (HA) which cause an acid reaction in the environmen and combine with mineral ions. In some situations a prevalence of humification over mineralization processes at sites of HA origin leads to a shortage of mineral substances for the complete saturation and neutralization of HA. Therefore, water flowing out of the peat bogs or soils during water excess periods is rich in the unsaturated, active HA which may combine with nutrients and other mineral ions only after their flowing into the water of adjacent lakes. The binding of minerals and HA produces complexes which precipitate into the bottom sediments; these complexes are unable to evoke the tendency of lake water towards either dystrophication or eutrophication. In cases where active HA flowing into the lake is insufficient to complex all of the load of nutrients released in the ecosystem, eutrophication will probably progress without any significant inhibition, particularly at alkaline or nearly neutral water conditions. Mainalkaine or nearly neutral water conditions. Main-taining an acid environment is the basic condition of the permanency of mineral-HA complexes. When the load of active HA predominates, the whole nutrient load is bound and precipitated, while the large content of active HA remaining maintains the acidity of the lake water and the permanence of the mineral-HA complexes. In this situation, the mechanism of lake distriction is situation the mechanism of lake dystrophication is situation the mechanism of lake dystrophication is in effect. In exceptional cases of lakes with approximately balanced loads of nutrients and active HA, with some prevalence of HA, the excess of HA remaining after precipitation is enough to acidify the water to a range suitable for the existence of mineral-HA complexes, but insufficient for dystrophication. Thus, the lake preserves its pseudo-oligotrophy. Studies of the de-eutrophication Lake Bikcze situated in an ombrophilous peat bog area provide evidence for these phenomena. (Sand-PTT) W91-09988

### **Group 2H—Lakes**

IDENTIFICATION OF NUTRIENT-LIMITED ALGAL GROWTH IN TWO STREAMS AT SHILLONG (INDIA).
North-Eastern Hill Univ., Shillong (India). Dept.

of Botany.

For primary bibliographic entry see Field 2E. W91-09989

INFLUENCE OF EXCHANGE FLOW BE-TWEEN THE CHANNEL AND HYPORHEIC ZONE ON NITRATE PRODUCTION IN A SMALL MOUNTAIN STREAM. Geological Survey, Menlo Park, CA. Water Re-

For primary bibliographic entry see Field 2E. W91-09993

FACTORS INFLUENCING FISH ASSEM-BLAGES AND SPECIES RICHNESS IN SUB-TROPICAL FLORIDA LAKES AND A COM-PARISON WITH TEMPERATE LAKES.

Florida Univ., Gainesville. Dept. of Environmental

Florida Univ., Gaintesvine. Dept. of Environmental Engineering Sciences.

A. E. Keller, and T. L. Crisman.
Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 47, No. 11, p 2137-2146, November 1990. 2 fig. 4 tab, 75 ref, append.

Descriptors: \*Acid lakes, \*Acid rain, \*Con Descriptors: 'Acti takes, 'Acti rain, 'Comparison studies, "Fish populations, "Florida, "Hydrogen ion concentration, "Species composition, "Water pollution effects, Aluminum, Heavy metals, Lake morphology, Lakes, Limnology, Literature review, Path of pollutants, Primary productivity, Subtropic zone, Temperate zone, Water chemistry.

Loss of fish from acidified lakes has been attributed Loss of hish from additional nakes has been authorized to heavy metal and alminium toxicity, recruitment failure, and direct pH effects on fish physiology. From detailed analyses of 36 lakes in which species assemblages and richness change with lake size, assembages and refiness change with lake size, trophic state, and pH, responses were not as dra-matic in Florida as in temperate lakes. At a given pH, more species were found in Florida lakes than in comparable lakes of the temperate zone. The impact of lake size on species richness was also less obvious in Florida lakes. The greater importance of centrarchids, increased contribution of the littoof centrarchids, increased contribution of the into-ral zone to primary production, and lower dis-solved aluminum levels may contribute to greater species richness in Florida lakes than in temperate lakes of comparable pH or size. Thus, while fish species richness declines with pH in Florida lakes, the decline is not solely the result of lake chemistry or the loss of particular species. Such observations suggest that factors structuring temperate fish communities in acidic lakes may be somewhat different from those underlying the response of fish in acidic Florida lakes. (Brunone-PTT) W91-09995

PERIPHYTON RESPONSES TO HIGHER TROPHIC LEVELS AND LIGHT IN A SHADED

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 2E. W91-09998

COMPARISON OF METHODS FOR ASSESSMENT OF NUTRIENT DEFICIENCY OF PHYTOPLANKTON IN A LARGE OLIGOTROPHIC LAKE.

LARE.
Montana State Univ., Bozeman. Dept. of Biology.
W. K. Dodds, and J. C. Priscu.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2328-2338,
December 1990. 7 fig, 3 tab, 43 ref. NSF Grant
BSP 870142.

Descriptors: \*Flathead Lake, \*Limiting nutrients, \*Limnology, \*Nutrient concentrations, \*Oligotrophic lakes, \*Phytoplankton, \*Species composition, Algal growth, Ammonium, Aquatic habitats, Aquatic plants, Bioassay, Carbon fixation, Chlorophyll a, Comparison studies, Montana, Phosphates,

Short-term and long-term changes in phytoplank-ton community physiology and biomass in re-

sponse to nutrient enrichment were used concomitantly as bioassays of phytoplankton nutrient defi-ciency in oligotrophic Flathead Lake, Montana, six times over the course of a year. Long-term bioas-says consisted of nutrient amendments to epilimnetic water in 20 L containers which were subsequently monitored for algal growth. Short-term bioassays included the measurement of ammonium ion stimulation of dark carbon fixation, measurenent of PO4(3-) on ammonium ion uptake and ammonium ion on PO4(3-) uptake. During thermal stratification, simultaneous addition of ammonium ion and PO4(3-) in long-term bioassays caused significant increases in chlorophyll a concentrasignificant increases in chiorophyli a concentra-tion, photosynthetic carbon-14 labeled carbon di-oxide uptake, and particulate nitrogen concentra-tion within 4.5 days; single additions of ammonium ion or PO4(3-) had little or no effect. During winter mixing, little evidence of nitrogen or phos-phorus deficiency exists in either short-term or long-term bioassays. In general, short-term bioas-says did not consistently agree with each other or says did not consistently agree with each other or with long-term bioassays. (Author's abstract) W91-09999

MEASUREMENT OF PHOSPHORUS UPTAKE LENGTH IN STREAMS: COMPARISON OF RADIOTRACER AND STABLE PO4 RE-

Oak Ridge National Lab., TN. Environmental Sci-For primary bibliographic entry see Field 2K. W91-10000

SIMULATION MODELING SYSTEM FOR AQUATIC BODIES, Akademiya Nauk SSSR, Moscow. Vychislitelnyi Tsentr.

For primary bibliographic entry see Field 7B. W91-10008

PATTERNS OF WATER CIRCULATION IN LAKE TOVEL (TRENTO, ITALY), (IL LAGO DI TOVEL (TRENTINO) E LA CIRCOLAZIONE DELLE SUE ACQUE).

Padua Univ. (Italy). Dept. of Biology. A. Paganelli, A. Miola, and P. Cordella. Rivista di Idrobiologia RIIDBN, Vol. 27, No. 2/3, p 363-376, 1988. 2 fig. 4 tab. 21 ref.

Descriptors: \*Lake Tovel, \*Limnology, \*Mountain lakes, \*Water circulation, Algal blooms, Alpine regions, Dissolved oxygen, Hydraulic conductivity, Italy, Meromictic lakes, Oligotrophic ductivity, Italy, Meromictic lakes, Oli lakes, Water chemistry, Water temperatus

Lake Tovel is a small (7,370,000 cubic m in volume and 382,000 sq m in area) alpine basin in Northern Italy. Every year since the 1960s, in late summer, the lake takes on a reddish hue from the algal blooms of Glenodinium sanguineum. Recently, this phenomenon has almost disappeared. The physical limnology of the probably oligotrophic lake shows a deeper layer which is almost always anoxic. Data taken from the literature and original unpublished data are shown for temperature, conductivity and oxygenation of the waters. Based on this data, the bottom water seems isolated from the rest of the water body; therefore the lake is classified as biogenic meromictic. (Author's abstract) W91-10009

FIELD STUDY OF THE EFFECTS OF WATER DEPTH, ORDER OF EMERGENCE AND FLOWERING ON THE GROWTH OF TYPHA GLAUCA SHOOTS USING THE RICHARDS MODEL

Monitoba Univ., Winnipeg. Dept. of Botany. I. Waters, and J. M. Shay. Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 231-242, March 1991. 2 fig, 3 tab, 27 ref.

Descriptors: \*Cattails, \*Emergence order, \*Emergent aquatic plants, \*Flowering, \*Limnology, \*Model studies, \*Plant growth, \*Richards equation, \*Water depth, Canada, Environmental fac-tors, Manitoba, Mathematical models, Variability.

The effects of water depth, order of emergence and flowering on growth curves of hybrid cattail

(Typha glauca) shoots growing in permanent quadrats in Crescent Pond, Manitoba, Canada, were analyzed using Ebert's formulation of the Richards function. Although estimate variability was high and heterogeneous, the model produced a good fit when applied to height measurements of individual shoots. The logistic (n=1) described the typical growth curve of vegetative shoots, with a grand mean of n=1.15. Although maximal size increased with depth in the 25 to 65 cm range, the shape parameter (n) of early emerging vegetative shoots was not substantially altered by position along the water depth gradient. The mean n value for the first vegetative cohort at 25 to 65 cm was 1.54. A substantial increase in estimate variability existed in substantial increase in estimate variability existed in substantial increase in estimate variability existed in the second vegetative cohort, suggesting that de-layed emergence imposes a greater stress on T. glauca shoot growth than water depth. The mean n value for all depths declined to n = 0.55. Floral shoots had a lower mean n value (n=0.28), coupled with low estimate variability and high weighted relative growth rates. These shoots divert resources from vegetative expansion. The Richards model may provide a sensitive tool for detecting the typical growth pattern of a species under field conditions, and for describing deviations from that pattern as a result of extrinsic and/or intrinsic factors. (Author's abstract) W91-10163

SOME OBSERVATIONS ON THE OXYGEN SENSITIVITY AND SEASONAL VARIATIONS OF THE NITROGENASE ACTIVITY ASSOCI-ATED WITH EXCISED SOIL-PLANT CORES OF PHRAGMITES AUSTRALIS (CAV.) TRIN. Dundee Univ. (Scotland). Dept. of Biological Sci-

Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 243-254, March 1991. 5 fig, 2 tab, 23 ref.

Descriptors: \*Enzyme activity, \*Limnology, \*Marsh plants, \*Nitrogenase, \*Oxygen requirements, \*Phragmites, \*Scotland, \*Sediment chemistry, \*Wetlands, Anoxic conditions, Core analysis, orfar Loch, Hydrogen ion concentration, Litter, Oxic conditions, Seasonal variation, Soil profiles,

The sensitivity of Phragmites soil-plant core a litter nitrogenase activity were assayed in Forfar Loch, Scotland, by the acetylene reduction assay method. Acetylene reduction activity (ARA) of soil-plant cores incubated under ambient oxygen concentrations increased with increasing pC2H2 up to 0.20 atm. A Km of 1.05 atm and V-max of 234 mmol C2HL/g/hour were calculated. The highest rates of ARA overall occurred in the 8 to 16 cm zone. Within the core profile, mean rates varied with depths: 0 to 8, 8 to 16, and 16 to 20 cm, and incubation pO2. In the 0 to 8 cm zone, ARA at pO2 0.00, 0.10, and 0.20 atm did not differ significantly, but in the 8 to 16 and 16 to 20 cm zones, the highest rates were obtained at pO2.00 atm. A lag method. Acetylene reduction activity (ARA) of highest rates were obtained at pO2 0.0 atm. A lag of approximately 5 hours preceded linear rates of litter ARA in time course assays. Change from aerobic to anaerobic atmospheres and the reverse substantially reduced core and excised root ARA for a period. Core ARA increased with incubation for a period. Core ARA increased with incubation temperature between 0 and 20 C; mean rates were the same at 20 and 25 C. ARA, numbers of diazotrophs, soil temperature, pH and Eh showed a seasonal pattern of variability. The highest rates of ARA were obtained between mid-May and June; peak numbers of diazotrophs were counted be-tween June and mid-July. Variations in soil pH were slight, but the most obvious change (6.3 to 7.5) occurred when the soil was warmest and most iced. (Author's abstract) W91-10164

INLET OF ALKALINE RIVER WATER INTO PEATY LOWLANDS: EFFECTS ON WATER QUALITY AND STRATIOTES ALOIDES L. STANDS.

Katholieke Univ. Nijmegen (Netherlands). Dept. of Aquatic Ecology and Biogeology.

J. G. M. Roelofs.

Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 267-293, March 1991. 17 fig, 4 tab, 42 ref.

Lakes-Group 2H

Descriptors: \*Alkalinity, \*Aquatic plants, \*Ecological effects, \*Land use, \*Limnology, \*Meuse River, \*Peat, \*Plant growth, \*Rhine River, \*Rivers, \*The Netherlands, \*Wetlands, Bioturbation, Carbonates, Eutrophication, Nutrient concentrations, Path of pollutants, Phosphorus, Soil physical properties, Sulfates, Suspended sediments, Turbidity, Water pollution effects, Water quality.

As a result of changed land use and concomitantly increased drainage, in combination with increased use of water for industrial, agricultural and other human purposes, an increasingly smaller supply of natural water occurs in many areas of the Netherlands in summer. To compensate for this shortage, increasing amounts of hard water from the Rhine and Meuse Rivers are diverted to these lowlands. The disappearance of the 'water soldier', Stratiotes aloides in party lowlands may be caused by aloides, in peaty lowlands may be caused by a decline of the water quality, owing to high concentrations of nutrients in the incoming water. However, field observations in 'de Weerribben', a large mire complex in the Netherlands, indicated that mire complex in the Netherlands, indicated that the decline of the water quality in this area is caused by an altered ion composition of the water. The incoming Rhine-type water from Lake IJsselmeer is very alkaline, irch in HCO3(-1) and SO4(-2). These anions appear to be responsible for a change in the decomposition processes. Consequently, the peat becomes very fine and soft, and because of increased bioturbation the water because the solution. because of increased bioturbation the water becomes turbid. As a result of increased reduction processes in the soil, phosphorus is increasingly mobile, leading to internal eutrophication and greatly increased levels of reduced compounds such as S2(-), CH4 and NH4(+) in the soft, upper layer of the bottom. Transplantation experiments with Stratiotes aloides plants showed that the plants started to decay in winter, after migration to the soft, upper sapropel layer. Culture experiments proved that the S(-2) and NH4(+) levels in this layer are lethal to Stratiodes plants. (Author's abstract) stract) W91-10165

UTILIZATION AND CONSERVATION OF EURYALE FEROX SALISBURY IN MITHILA

CNORTH BIHAR), INDIA.
Department of Botany, C. M. Science College,
Darbhanga-846 004, Bihar, India.
V. Jha, A. N. Kargupta, R. N. Dutta, U. N. Jha,

Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 295-314, March 1991. 1 fig, 145 ref. Department of Science and Technology Project No. SP/YS/L-32/85.

Descriptors: \*Agriculture, \*Aquaculture, \*Aquatic plants, \*Catchment areas, \*Conservation, \*Crop production, \*Environmental effects, \*Erosion, plants, \*Catchment areas, \*Conservation, \*Crop production, \*Environmental effects, \*Erosion, \*India, \*Makhana, Floods, Hydrogen ion concen-tration, Plant growth, Population density, Sediment chemistry, Sediment load, Standing waters, Temperate climates, Water chemistry, Water depth.

Euryale ferox, locally known as makhana, is the main aquatic cash crop of Mithila (North Bihar), India. Thousands of natural and man-made water-India. I nousands of natural and man-made water-bodies of the region are ideal reservoirs for com-bined fish and makhana cultivation. Ecological studies of E. ferox have shown that the growth and decomposition of the plant parts and the depth of decomposition of the plant parts and the depit of standing water have great impact on soil and water properties. The plant grows in near neutral pH of both sediment and water and a sediment C:N ratio of about 10. The plant's flowers open on the water surface for two to three days, and the seeds float until they settle to the waterbody bottom. Early tender leaves of the crop require protection from larval and adult insect pests. E. ferox has become extinct in the temperate lakes of Kashmir and has become rare in the contemporaneous flora of Eurasia. Major parts of the flood-ravaged northeastern districts of North Bihar have witnessed a virtual root-out of the crop, because sand fills the water-body beds. (Brunone-PTT)

CHARACTERIZATION OF AXENIC CULTURE SYSTEMS SUITABLE FOR PLANT PROPAGA-

TION AND EXPERIMENTAL STUDIES OF THE SUBMERSED AQUATIC ANGIOSPERM POTAMOGETON PECTINATUS (SAGO POND-

WEED),
Maryland Univ., College Park. Dept. of Botany.
A. S. Ailstock, W. J. Fleming, and T. J. Cooke.
Estuaries ESTUDO, Vol. 14, No. 1, p 57-64,
March 1991. 2 fig, 5 tab, 37 ref.

Descriptors: "Culturing techniques, "Limnology, "Nutrient concentrations, "Plant growth, "Sago pondweed, "Submerged aquatic plants, "Water pollution, "Wetlands, Aquatic habitats, Aquatic plants, Field tests, Light intensity, Photosynthesis, Tuchkidir.

Nutrient enrichment, increased turbidity, and chemical pollution have all been implicated as contributors to observed changes in submerged aquatic angiosperm populations. Clonal lines of the submerged aquatic angiosperm Potamogeton pectina-tus were grown in three culture systems. The first, which used sucrose as a carbon source in a liquid medium, supported vigorous vegetative growth and can be used to propagate large numbers in axenic conditions. In this culture system, plants were responsive to increasing photosynthetically active radiation photon flux density and were photosynthetically competent. However, their growth tosynthetically competent. However, their growth was heterotrophic and root development was poor. When these plants were transferred to a second nonaxenic culture system, which used 16 L buckets containing artificial sediments and tap water, growth was autotrophic and plants were morphologically identical to field-harvested P. pectinatus. The last culture system which consisted of a sand substrate, and inorganic nutrient bathing solution. substrate and inorganic nutrient bathing solution aerated with 135 ml/min ambient air enhanced to aerated with 130 ml/min amoient air ennanced to 3.0% CO2 was axenic and supported autotrophic growth by plants that were also morphologically normal. Taken collectively, the different culture systems provide a valuable alternative for studying the growth and development of submerged aquatic angiosperms in natural and modified environments. (Author's abstract)

PRESSURIZED VENTILATION IN WETLAND

PRESSUREMENT OF THE PLANTS.
Cologne Univ. (Germany, F.R.). Botanisches Inst.
W. Grosse, H. B. Buchel, and H. Tiebel.
Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 8998, February 1991. 4 fig, 2 tab, 16 ref.

Descriptors: \*Limnology, \*Marsh plants, \*Plant physiology, \*Rooted aquatic plants, \*Wetlands, Anoxic conditions, Aquatic habitats, Gases, Thermo-osmosis, Transpiration, Ventilation.

Species of wetland plants that aerate their submerged organs by thermo-osmotic transport of gas have been identified in 6 genera of the angiosperm families Butomaceae, Nymphaeaceae and Menyanthaceae. Flow rates of 14 ml gas/h in the monocotyledon Hydrocleys nymphoides to 5000 ml/h in the dicotyledon Victoria amazonica are comparable to those rates found in Nelumbo nucifera from the Nelumbonacean family, but an order higher than those in Alnus glutinosa from the Betulacean family. The aeration is driven by a pressurization of the gas in the aerenchyma of young floating leaves as a consequence of the physical effect of thermo-osmosis of gases. Differences in the hygrometric state of the leaves and the ambient air affect the flow rates. Increased transpirational cooling of the upper leaf surface seems to give rise to a steeper temperature gradient within the leaf, intensifying the aeration. As these five plant families are not closely related, the ability to generate a pressurized ventilation by thermo-osmosis of gas can be seen as a special adaptation. Species of wetland plants that aerate their subty to generate a pressurized ventilation by thermo-osmosis of gas can be seen as a special adaptation of wetland plants to the anoxic environment. (Author's abstract) W91-10197

VARIATION IN GROWTH RATES OF SUB-MERGED ROOTED MACROPHYTES.

Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab. S. L. Nielsen, and K. Sand-Jensen. Aquatic Botany AQBODS, Vol. 39, No. 1/2, p

109-120, February 1991. 3 tab, 34 ref.

Descriptors: \*Macrophytes, \*Plant growth, \*Sub-merged plants, Carbon, Photosynthesis, Plant physiology, Rooted aquatic plants.

Above-ground growth rates of 14 temperate, sub-merged freshwater macrophytes were measured in the laboratory at high dissolved inorganic carbon levels (3.3-3.8 mM), nutrient saturation and photon flux densities (photosynthetically active radiation (PAR)) of 14.4 mol/sq m/day at 15 C. Growth rates ranged from 0.007 to 0.109/day, corresponding to doubling times of 95 and 6.4 days. Growth rates of selected species measured at low shoot densities in the field during summer resembled the laboratory rates. The carbon affinity during photosynthesis accounted for 61% of the observed varia-bility in growth rates. These results support previ-ous findings demonstrating the importance of carbon utilization for the distribution, abundance caroon utilization for the distribution, abundance and growth of submerged macrophytes. The carbon affinity was a constant attribute for some species, including the slowly growing rosette species, but changed during acclimatization in the laboratory for other species. Morphological features (e.g. the surface/volume ratio) were unable to account for much of the variability in growth rates. (Author's abstract)

SURVIVAL OF A POTAMOGETON PECTINA-TUS I. POPULATION UNDER VARIOUS LIGHT CONDITIONS IN A SHALLOW EU-TROPHIC LAKE (LAKE VELUWE) IN THE NETHERLANDS.

Agricultural Univ., Wageningen (Netherlands).

Agricultural Only, wageinigen (Netherlands). Dept. of Nature Conservation.

G. M. Van Dijk, and W. Van Vierssen.
Aquatic Botany AQBODS, Vol. 39, No. 1/2, p. 121-129, February 1991. 2 fig, 1 tab, 21 ref.

Descriptors: \*Eutrophic lakes, \*Limnology, \*Netherlands, \*Photosynthesis, \*Plant growth, \*Pondweeds, \*Submerged plants, Aquatic habitats, Biomass, Lake Veluwe, Light quality, Plant physi-\*Limnology, ology.

In Lake Veluwe, a eutrophicated shallow lake in The Netherlands, light conditions significantly affected the total biomass production of a Potamogeton pectinatus vegetation. A negative correlation was recorded between the annual biomass production and the mean daily photon flux densities in an experimental setup in which the photon flux densities were experimentally manipulated (4 different levels of artificial shading) and the photoperiod was relatively unaffected. At the lowest mean levels of artificial shading) and the photoperiod was relatively unaffected. At the lowest mean photon flux density, the maximum total biomass was reached earlier in the growing season (end of June) than at the other photon flux densities (mid-August). Tuber production started at the same time in all conditions (mid-June). The number of tubers recommend the production of tubers are considered to the production of tubers. produced per gram ash-free dry weight of above-ground biomass was highest for the conditions with the lowest mean daily photon flux density. However, the total number of tubers per square meter recorded at the end of the growing season was highest for the control (no artificial shading). Tuber initiation occurs under long-day conditions Tuber initiation occurs under long-day conditions and is not controlled by mean daily photon flux densities. Tuber growth is clearly related to differences in daily photosynthetic periods. Tubers compete with above-ground biomass for photosynthate. At the highest level of shading, the photosynthetic tissue was ultimately unable to sustain tuber growth and, as a consequence, net growth of the vegetation ceased. Regarding tuber numbers of P. pectinatus in late summer, the size of the tuber bank was negatively affected by shade in the exents. (Author's abstract)

PRINCIPAL DETERMINANTS OF AQUATIC MACROPHYTE RICHNESS IN NORTHERN EUROPEAN LAKES.

Norsk Inst. for Vannforskning, Oslo. B. Rorslett.

Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 173-193, February 1991. 4 fig, 8 tab, 55 ref, append.

## **Group 2H—Lakes**

\*Lake ecology, Descriptors: \*Aquatic plants, \*Lake ecology, \*Limnology, \*Macrophytes, \*Trophic level, Acidity, Aquatic habitats, Biogeography, Denmark, Eutrophic lakes, Finland, Lake morphology, Model studies, Norway, Oligotrophic lakes, Species diver-

Determinants of macrophyte species richness were evaluated using data from 641 lakes in Norway, Sweden, Denmark and Finland. The species pool of aquatic macrophytes was carefully delineated prior to establishing the recorded number of species for any lake. The expected richness for a vector of environmental variables was related to lake area, altitude, trophic state and several water quality variables. Neither the size of the regional species pool nor the latitude affected the number of species appreciably. Area contributed most to expecies appreciably. species pool nor the latitude affected the number of species appreciably. Area contributed most to explain variation in species richness; this contribution could be modeled by a Weibull-type curve. The power function employed by the theory of island biogeography is a limiting case of the Weibull model. Residual analysis identified factors which either increased or decreased species richness. A number of cases of low species richness and low floral diversity related to lake regulation, low pH or hypertrophication. Elevated species richness oc-curred most often within quite small, often mesotrophic lakes which had undergone lowering of their surface levels. Lakes exhibiting a highly astheir surface levels. Lakes exhibiting a mgnly as-sorted macrophyte flora often experience interme-diate disturbance and stress from moderate alter-ations of their water levels (1-3 m/yr). Overall, meso-oligotrophic lakes supported higher species richness than did either oligotrophic or highly eutrophic lakes. (Author's abstract) W91-10200

MECHANISMS FOR MAINTAINING PERSIST-ENT POPULATIONS OF MYRIOPHYLLUM VARIIFOLIUM J. HOOKER IN A FLUCTUAT-ING SHALLOW AUSTRALIAN LAKE.

University of New England, Armidale (Australia). Dept. of Botany. M. A. Brock.

Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 211-219, February 1991. 2 fig, 2 tab, 12 ref, Austra-lian /research Grant No. D1 85 15718.

Descriptors: \*Aquatic plants, \*Australia, \*Lake ecology, \*Limnology, \*Pondweeds, Aquatic habitats, Life cycles, Plant growth, Population dynamics, Reproduction, Shallow water.

Plant populations in many shallow Australian lakes are subject to wide fluctuations of environmental factors such as drying and rewetting of habitats seasonally or aseasonally. The life cycle and reproductive flexibility, and exchange of reproductive material between habitats, as a means of maintaining persistent populations of the same species in different habitats, were investigated. In a shallow lake, Myriophyllum variifolium grows in both temporary and permanent water habitats separated by portary and permanent water nationals separated by a zone of open water. Established plants in these two habitats differ in growth form, yet produce both asexual and sexual propagules. Field experiments and observations on the germination, ments and observations on the germination, growth and reproduction of this species demonstrate that the populations of established plants in both habitats have means of contributing to the establishment of new plants in either habitat under estationsment of new plants in either natifiat under a range of environmental conditions. Such flexibil-ity of life cycle pattern and plasticity of growth form enhance survival in these widely fluctuating environments. (Author's abstract) W91-10201

MEASUREMENT OF CURRENT VELOCITIES IN MACROPHYTE BEDS.

Vienna Univ. (Austria). Inst. fuer Pflanzenphysiologie. For primary bibliographic entry see Field 7B. W91-10202

EFFECT OF VARIOUS AQUATIC BACTERIA ON THE GROWTH AND SENESCENCE OF DUCKWEED (LEMNA MINOR).

Sussex Univ., Brighton (England). School of Biological Sciences

G. J. C. Underwood, and J. H. Baker. Journal of Applied Bacteriology JABAA4, Vol. 70, No. 3, p 192-196, March 1991. 2 fig, 2 tab, 23

Descriptors: \*Aquatic bacteria, \*Duckweed, \*Floating plants, \*Limnology, \*Plant growth, Enterobacter, Klebsiella, Population density, Population dynamics, Pseudomonas, Senescence, Serratia,

Five different species of freshwater bacteria (Pseudomonas sp., Vibrio sp., Klebsiella sp., Enterobacter sp., Serratia sp.) and a mixed natural population were used separately to inoculate cultures of axenic duckweed (Lemna minor). Inoculation with Vibrio sp. caused the final population density of Lemna plants to be significantly greater after 52 d than that of either axenic controls or Lemna inocul-lated with a mixed bacterial community. Inoculation with Pseudomonas sp. caused the final popula-tion density of Lemna to be significantly higher than with the mixed bacterial treatment. Inocula-tion of Lemna with Klebsiella sp., Enterobacter sp. or Serratia sp. resulted in higher plant populations compared with controls, but these differences were not statistically significant. The presence of a mixed community of bacteria did not significantly affect the final population density of Lemna com-pared with the controls. However, Lemna plants inoculated with a natural population of bacteria showed significantly higher levels of senescence compared with the other five treatments and the controls. None of the five taxa appeared to have any significant effect on the senescence of duckweed. (Author's abstract) W91-10210

SUNLIGHT AND THE SURVIVAL OF ENTERIC BACTERIA IN NATURAL WATERS,

Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 5A. W91-10212

DISTRIBUTION AND FLUXES OF METALS IN THE ST. LAWRENCE RIVER FROM THE OUTFLOW OF LAKE ONTARIO TO QUEBEC

Direction, Ecotoxicologie et Ecosystemes, Centre St. Laurent, 105 rue McGill, Montreal H2Y 2E7, Quebec, Canada.

For primary bibliographic entry see Field 5B. W91-10213

NATURAL RECOLONIZATION OF A PRO-DUCTIVE TROPICAL POND: DAY TO DAY VARIATIONS IN THE PHOTOSYNTHETIC PARAMETERS,

Centre de Recherches Oceanographiques, Abidjan

Centre de Rechelenes Occanogary, (Ivory Coast). R. Arfi, G. Guiral, and J. P. Torreton. Aquatic Sciences AQSCEA, Vol. 53, No. 1, p 39-54, 1991. 7 fig, 2 tab, 40 ref.

Descriptors: \*Limnology, \*Photosynthesis, \*Phytoplankton, \*Ponds, \*Primary productivity, \*Recolonization, \*Succession, Algal blooms, Aquaculture, Aquatic habitats, Biomass, Chlorophyll, Ivory Coast, Particulate nitrogen, Tropical re-

Chlorophyll pigments, primary productivity, and particulate N in relation to several environmental factors were monitored during planktonic colonization of an aquaculture pond (Layo, Ivory Coast). How interactions between the organisms are estab-lished in an initially azoic environment were inves-tigated. From March 15 (D1) to March 31 (D16), tigated. From March 15 (D1) to March 31 (D16), the system transformation went through three stages. The first stage was a precolonization by heterotrophic microbial community from D1 to D2 (particulate N < 1 micron maximum at D2: 243 mg/sq m; chlorophyll around 0). In the second stage, a pioneer microalgal community developed from D3 to D7 (maximum chlorophyll on D6: 19 mg/sq m; primary productivity: 1.0 g C/sq m/d) with a significant contribution of picoplankton (chlorophyll and primary productivity <3 microns: 33 and 23% of the total, respectively). Fi-

nally, a second microalgal colonization was noticed from D9 to D12 (maximum chlorophyll: 55 mg/sq m; primary productivity: 2.8 g C/sq m/d), largely dominated by nanoplankton (chlorophyll and primary productivity > 3 micron:95 and 99% of the total, respectively). Overall, photosynthetic activity appeared to be closely linked to algal biomass. The study of autotrophic biomass and activity in different size classes in relation to the other parameters allowed the determination of the other parameters allowed the determination of the origin of the biomass fluctuations. The first bloom origin of the olomass indicutations. The inst bloom appeared to be controlled by selective grazing on small algae. The second algal development ended when N requirement represented at least 69% of N supply (in the N-NH4 form). This control was enhanced by the appearance of rotifers, leading to a more complex equilibrium. (Author's abstract) WM1.10214. W91-10214

EVALUATION AND APPLICATION OF DIALYSIS POREWATER SAMPLERS FOR MICRO-BIOLOGICAL STUDIES OF SEDIMENT-WATER INTERFACES,

Zurich Univ. (Switzerland). Inst. of Plant Biology. For primary bibliographic entry see Field 7B. W91-10215

DIATOM, POLLEN, AND SEDIMENT MI-CROSTRATIGRAPHIC INVESTIGATIONS OF ANTHROPOGENIC EFFECTS ON LAKE HOELLER (UPPER AUSTRIA) (DIATOMEEN, POLLEN, AND SEDIMENTMIKROSTRATI-GRAPHISCHE UNTERSUCHUNGEN ZUR ANTHROPOGENEN BEEINFLUSSUNG DES HOELLER SEES (OBEROSTERREICHI).

Akademie der Wissenschaften der DDR, Berlin. R. Schmidt, and H. Simola.

Aquatic Sciences AQSCEA, Vol. 53, No. 1, p 74-89, 1991. 8 fig, 1 tab, 24 ref. English summary.

Descriptors: \*Anthropogenic effects, \*Diatoms, \*Eutrophication, \*Lake sediments, \*Limnology, \*Mesotrophic lakes, \*Paleolimnology, \*Pollen, \*Sediments, \*Stratigraphy, Agriculture, Austria, Forests, Hollerer See, Sediment analysis.

A profundal sediment core from Hollerer See, a kettle lake in the pre-alpine lowland in Upper Austria, frozen in situ was studied by means of diatom, microstratigraphical tape peel and pollen analysis. The core contained two laminated (varved) sequences with regular calcareous layers. In the upper sequence (0-4 cm; A) these varves average 2.5 mm thick and number about 16. In the lower sequence (74-100 cm; C), varve thickness varies with respect to allochthonous influx and the varves are interrupted by homogeneous sequences. The lower sequence is interpreted as representing the medieval settlement phase (12th and 13th century) during which the lake was eutrophicated. In the massive section B between the laminated sequences the increased percentage of arboreal pollen indicates regrowth of forests near the lake, diatom flora reflect mesotrophication of the lake. Considerable slowing down of the sediment accu-mulation rate is assumed for this sequence, which may be correlated with a decrease in local popula-tion until the 14th and 16th century. Further intensification of agriculture, soaking of hemp and human activities around the lake have caused changes in trophic conditions, pH and sedimenta-tion during section B. A recent eutrophic phase starts according to varve counts during the 1970's, probably due to increased nutrient loading of the lake and coinciding with clearance of meadowland and numerous bathing lots on the paludified lake marl fringe around the lake. Microstratigraphy of diatoms, other algae, zooplankton remains, and pollen grains were analyzed with 0.33 mm vertical resolution. For the unper laminated next in which changes in trophic conditions, pH and sedimentaportion grains were analyzed with 0.53 min vertical resolution. For the upper laminated part, in which the laminae are thick and regular, it was possible to sum up the average stratigraphy of all these re-mains within a varve. (Author's abstract) W91-10216

TRAPPED SEAWATER IN TWO NORWEGIAN LAKES: KILEVANNET, A NEW LAKE WITH OLD TRAPPED SEAWATER, AND ROR-

Telemark Coll. (Norway). K. Barland. Aquatic Sciences AQSCEA, Vol. 53, No. 1, p 90-98, 1991. 2 fig, 6 tab, 18 ref.

Descriptors: \*Geothermal water, \*Lake morphometry, \*Lake stratification, \*Meromictic lakes, \*Seawater, \*Water chemistry, Chemocline, Lake Kilnevannet, Lake Rorholtfjorden, Norway, Salinity, Solar radiation, Stagnant layer, Stratification, Water temperature.

Kilevannet is a meromictic lake in southern Norway. The stagnant bottom water probably originates from the last post-glacial period in Norway, 8000-9000 years ago. Close to Kilevannet is Rorholtfjorden, another lake with presumably old trapped seawater at its bottom. The most striking difference between the two lakes is the absence of a semi-stagnant layer in Rorholtfjorden. This layer, with gradually increasing salinity and decreasing oxygen content, seems to have a market creasing oxygen content, seems to have a marked influence on the stability of the stratification. In Rorholtfjorden the chemocline is situated between 136 and 137 m, compared to 57-59 m for Kilevannet, with oxygen saturations of 81% and 0%, respectively at these depths. In less than one meter the physical and chemical conditions change dramatically, and the salinity gradient is extremely steep. The physical and chemical differences between the two lakes is probably due to corresponding differences in the drainage areas and in the lakes themselves. Both surface area and wind fetch are many times larger in Rorholtfjorden than in Kilevannet. The shoreline of the basin containing salt water in Kilevannet is convoluted, and the shelter from the wind is probably one of the main reasons for better preservation. Another difference is the significantly higher temperature in the stag-nant bottom water of Kilevannet. While this could nant oottom water of Alexander. While this could
be due to the greater depth in Rorholtfjorden,
thereby minimizing any thermal effects of solar
radiation, this seems unlikely because of rapid absorption of solar radiation, and the effect should be One explanation may be smaller monimolimnetic volume in Kilevannet, thereby increasing the effect of geothermal heat accumulation. (Sand-PTT) W91-10217 imal even at a depth of 90 m in Kilevannet.

CONTRASTING TROPHIC LEVEL INTERAC-TIONS IN LAKE ST. GEORGE AND HAYNES LAKE (ONTARIO, CANADA). York Univ., Downsview (Ontario), Dept. of Biol-

ogy. N. Lafontaine, and D. J. McQueen. Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 48, No. 3, p 356-383, March 1991. 5 fig, 6 tab, 33 ref.

Descriptors: \*Fish populations, \*Food chains, \*Haynes Lake, \*Lake St George, \*Lake ecology, \*Limnology, \*Phytoplankton, \*Trophic level, \*Zooplankton, Aquatic habitats, Canada, Chlorophyll a, Ontario, Phosphorus, Water chemistry.

Two small, adjacent kettle lakes in southern Ontar-Two small, adjacent kettle lakes in southern Ontar-io were sampled during spring and summer 1987. The data comprised weekly samples of zooplank-ton and water chemistry, monthly diel assessments of the densities of pelagic fish and zooplankton found at 1-m depth intervals in the water column, and an annual mark and recapture assessment of the entire fish population. The two lakes had very different community structures. Haynes Lake was characterized by high piscivore numbers, few planktivores, a relatively large assemblage of large bodied zooplankton, low chlorophyll a concentrations, and clear water. Lake St. George had a tions, and clear water. Lake St. Oeorge had a lower pisciover to planktivore ratio, smaller zoo-plankton, more chlorophyll a, and murkier water. Comparisons of trophic level biomasses for the two lakes suggested that in both communities, the relationships between piscivores and planktivores and between planktivores and zooplankton were strongly correlated with predator abundances. In the more oligotrophic community (Haynes Lake) the more ongotrophic community (raymes Lake) this influence extended weakly to the phytoplankton, but in the more eutrophic system, little of the variability in chlorophyll a with respect to total phosphorus could be explained by total zooplankton (or Daphnia) abundance. This suggests that for

freshwater pelagic communities, top-down effects may be stronger in more oligotrophic systems. (Author's abstract) W91-10220

LAKE TROUT (SALVELINUS NAMAYCUSH) CONTROL OF SNAIL DENSITY AND SIZE DISTRIBUTION IN AN ARCTIC LAKE.

Minnesota Univ.-Duluth. Dept. of Biology G. W. Merrick, A. E. Hershey, and M. E. McDonald.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 498-502, March 1991. 3 fig, 2 tab, 24 ref. NSF Grant No. DPP 8320544.

Descriptors: \*Introduced species, \*Lakes, \*Predation, \*Snails, \*Trout, Alaska, Aquatic habitats, Arctic, Population density.

In arctic Alaskan lakes the density and size distri-bution of the snail Lymnaea elodes appear to be greatly affected by the presence or absence of lake trout (Salvelinus namaycush). Snail densities were much lower and size distributions depressed in lakes where trout were present. During the summer of 1986, lake trout were introduced into an arctic lake to test the effects of their predation on the dominant snail L. elodes. During July and early August, snail densities in the experimental lake remained stable in the deepwater areas of the lake, but increased significantly in the deepwater areas of an adjacent, troutless control lake, probably due to snail migration from the lake periphery in the absence of predation pressure. These results suggest that the observed pattern of snail distribu-tion and size in lakes containing trout is due to trout predation. (Author's abstract) W91-10222

EFFECT OF TEMPERATURE, SEASON, AND FISH SIZE ON ACUTE LETHALITY OF SUSPENDED SEDIMENTS TO COHO SALMON (ONCORHYNCHUS KISUTCH).

Department of Fisheries and Oceans, Cultus Lake (British Columbia). Cultus Lake Salmon Research

J. A. Servizi, and D. W. Martens.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 493-497, March 1991. 3 fig, 1 tab, 17 ref.

Descriptors: \*Fish pathology, \*Fish physiology, \*Mortality, \*Salmon, \*Suspended sediments, \*Water pollution effects, Aquatic habitats, British Columbia, Canada, Fraser River, Season, Water

A study was conducted to define lethal and near-lethal values for suspended sediment over a natural temperature range experienced by juvenile coho remperature range experienced by juvenile coho salmon. Tolerance of underyearling coho salmon to Fraser River, British Columbia, suspended sediments at 7 C was independent of season and year. However, coho of 0.52 g (4.0 cm) possessed only 35% of the tolerance of larger specimens. Tolerance to suspended sediments was temperature dependent, with 96-h LC50 at 1 and 18 C being 47 and 33%, respectively, of the value at 7 C Telerance 10 suspended sediments was temperature dependent, with 96-h LC50 at 1 and 18 C being 47 pendent, with 96-h LC50 at 1 and 18 C being 47 and 33%, respectively, of the value at 7 C. Tolerance was further reduced among underyearling coho which were later found to have a viral kidney infection. Cough reflex, oxygen saturation levels, metabolic rates, and capacity to do work all probably affect the relationship between suspended sediment tolerance and temperature. (Author's abstract) W91-10223

PIGMENT PRESERVATION IN LAKE SEDI-MENTS: A COMPARISON OF SEDIMENTARY ENVIRONMENTS IN TROUT LAKE, WISCON-

Wisconsin Univ.-Madison. Water Chemistry Pro-

gram.
J. P. Hurley, and D. E. Armstrong. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 472-486, March 1991. 7 fig, 6 tab, 78 ref. NSF Grants DEB 8514430 and EAR 8816561.

Descriptors: \*Biogeochemistry, \*Diagenesis, \*Lake sediments, \*Limnology, \*Pigments, \*Sediment-water interfaces, Carotenoids, Chlorophyll a, Epilimnion, Trout Lake, Wisconsin.

Fluxes and concentrations of a phorbins and major algal carotenoids were quantified in sediment trap material and sediment cores from two basins of Trout Lake, Wisconsin (TrDH and TrAB). The basins were chosen to contrast the influence of oxygen content at the sediment-water interface (TrDH, oxic and TrAB, reducing), sediment accumulation rate, and focusing. Pigment diagenesis occurred in both basins, but transformations and destruction were more extensive in TrDH. Although untransformed chlorophyll a was the major phorbin deposited at the sediment surface of both basins (51-64 mol%), pigment destruction, coupled basins (31-04 mol%), pigment destruction, coupled with transition to pheophytin, accounted for substantial losses, especially in oxic TrDH sediments. Fucoxanthin, peridinin, and diadinoxanthin, despite representing >70% of the deposited carotenoid flux, were substantially degraded or transformed in both basins. However, preservation was relatively high for secondary carotenoids, such as diatoxanthin and beta-carotene, and for a major crypto-monad pigment, alloxanthin. Residual profiles in sediments show that pigment sedimentation from the epilimnion and accumulation in the permanent sediments are not directly related and that diagene-sis must be considered in interpreting sedimentary pigments. (Author's abstract) W91-10224

EFFECT OF ENVIRONMENTAL PH ON THE HEPATIC MIXED FUNCTION OXIDASES IN ATLANTIC SALMON (SALMO SALAR).

Bedford Inst. of Oceanography, Dartmouth (Nova

For primary bibliographic entry see Field 5C. W91-10225

EFFECTS OF MOOSE BROWSING ON DE-COMPOSITION RATES OF BIRCH LEAF LITTER IN A SUBARCTIC STREAM. Alaska Univ., Fairbanks. Inst. of Arctic Biology.

Alaska Univ., Fairoanks. Inst. of Arctic Biology. J. G. Irons, J. P. Bryant, and M. W. Osgood. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 442-444, March 1991. 1 fig. 26 ref. NSF Taiga Forest Long Term Ecological Research Grant BSR-8702629.

Descriptors: \*Birch trees, \*Detritus, \*Food chains, \*Leaves, \*Litter, \*Riparian vegetation, \*Streams, Alaska, Decomposition, Herbivore browsing, Moose. Subarctic zone.

The effects of moose browsing on decomposition rates of paper birch leaves was examined in Monument Creek, a subarctic headwater stream near Fairbanks, Alaska. Leaves from birch trees previously browsed by moose differed from leaves from unbrowsed trees in food quality for stream detrivores in an Alaskan subarctic stream. Leaves from votes in an Anasan suparctic stream. Leaves from previously browsed plants decomposed faster. Ef-fects of browsing were tested by collecting leaves from previously browsed and unbrowsed trees and measuring loss of mass over time in an Alaskan subarctic stream. The browsing history of birch trees was associated with increased leaching rate of tannin, foliar nitrogen concentration, and rate of mass loss. All three factors were higher for leaves from trees previously browsed than for unbrowsed ones. Faster loss of tannin through leaching and higher foliar nitrogen concentration apparently caused birch detritus to be processed more rapidly caused orich dertrus to be processed more rapiuty by stream biota, potentially increasing secondary production of stream consumers. Hence, moose browsing was associated with important changes in the food quality of birch leaf litter, linking terres-trial herbivory and aquatic food webs. (Sand-PTT) W91-10226

ADRENERGIC RESPONSE TO PHYSIOLOGI-CAL DISTURBANCES IN RAINBOW TROUT, ONCORHYNCHUS MYKISS, EXPOSED TO ALUMINUM AT ACID PH.

Centre d'Etude de l'Energie Nucleaire, Mol (Bel-gium). Lab. for Mineral Metabolism.

## Group 2H-Lakes

For primary bibliographic entry see Field 5C. W91-10227

CONCENTRATION AND DISTRIBUTION OF PCB CONGENERS IN ISOLATED ONTARIO AKES CONTAMINATED BY ATMOSPHERIC DEPOSITION.

Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
For primary bibliographic entry see Field 5B.
W91-10228

INITIAL FEEDING TIME OF ATLANTIC SALMON, SALMO SALAR, ALEVINS COMPARED TO RIVER FLOW AND WATER TEMPERATURE IN NORWEGIAN STREAMS.
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway)

heim (Norway).
A. J. Jensen, B. O. Johnsen, and T. G. Heggberget.
Environmental Biology of Fishes EBFID3, Vol.
30, No. 4, p 379-385, April 1991. 2 fig, 2 tab, 29 ref.

Descriptors: \*Fish behavior, \*Food habits, \*River flow, \*Salmon, \*Water temperature, Aquatic habitats, Norway, Streamflow.

The time of initial feeding of Atlantic salmon alevins in 10 geographically widespread Norwegian streams was estimated theoretically by combining data on spawning time and models describing the data on spawning time and models describing the time from fertilization to hatching and from hatch-ing to initial feeding at different temperatures. The point of initial feeding was correlated with water flow and water temperature regimes. Initial feed-ing was avoided in all rivers during spring peak flow, and before water temperature reached 8 C. Two different strategies were indicated: (1) initial feeding may take place before the culmination of the spring flow, or (2) after the peak spring flow.

The choice of strategy depends on temperature and flow regimes in each river. (Author's abstract) W91-10229

NUTRIENT REGENERATION BY ZOOPLANK-TON: EFFECTS ON NUTRIENT LIMITATION OF PHYTOPLANKTON IN A EUTROPHIC

Univ.-Madison. Center for Limnology. S. M. Moegenburg, and M. J. Vanni. Journal of Plankton Research JPLRD9, Vol. 13, No. 3, p 573-588, 1991. 6 fig, 18 ref. Federal Aid in Sport Fish Restoration Act, Project F-95-P.

Descriptors: \*Cycling nutrients, \*Eutrophic lakes, \*Limiting nutrients, \*Limnology, \*Phytoplankton, \*Zooplankton, Lake Mendota, Lake Wingra, Nitrogen, Nutrients, Phosphorus, Wisconsin.

To test the hypothesis that excretion of nutrients by zooplankton can reduce the severity of nutrient by zoopsiatkon can feduce the severity of nutrient ilimitation of phytoplankton, and determine whether the phytoplankton community is limited by nitrogen or phosphorus, in situ experiments were conducted in eutrophic Lake Mendota, Wisconsin, during the summer of 1988. In this lake, phytoplankton were limited by N and P, but periods of plankton were limited by N and P, but periods of nutrient limitation were transitory. Increased zoo-plankton biomass and the consequent increased excretion of nutrients by zooplankton reduced P limitation (as measured by specific alkaline phos-phatase activity) in all experiments. Excretion of nutrients also reduced N limitation (as measured by ammonium enhancement response), in one of three ammonium enhancement response) in one of three ammonium ennancement response) in one of times experiments. In additional experiments in the more highly eutrophic Lake Wingra, excretion of nutrients by zooplankton reduced both N and P limitation. These results support the hypothesis that zooplankton have potentially important indirect effects on phytoplankton communities through recycling of nutrients. (Author's abstract) W91-10232

FLOODPLAIN FOREST ECOSYSTEM. PART I: BEFORE WATER MANAGEMENT MEAS-URES.

ORES, Brno Univ. (Czechoslovakia). M. Penka, M. Vyskot, E. Klimo, and F. Vasicek. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing

Co., New York. 1985. 466p.

Descriptors: \*Czechoslovakia, \*Flood plain management, \*Flood plains, \*Forest ecosystems, \*Forest watersheds, Dyje River, Flood plain ecology, Floodplain forests, Morava River, Water re-

One of the major problems facing mankind is the rational exploitation of natural resources and the creation and conservation of an acceptable envi-ronment. Therefore, a study was conducted of the relationships between organisms and their inorgan-ic environment in both natural ecosystems and in those altered by man. Specialists at the Faculties of Forestry and Agronomy of the Brno Agricultural University set up a long-term research project to study the floodplain forests along the Rivers Dyje and Morava, including neighboring field and meadow ecosystems. In the late sixties and early meadow ecosystems. In the late sixtles and early seventies the region was the scene of extensive hydrological regulation, which had a marked effect on the ecology of this mainly agricultural area. This provided an opportunity to study the effects of a major modification of one of the important abiotic components of the environment-water-with complex consequences reflected mainly in the biological processes within the terrestrial and aquatic ecosystems. A summary is presented of the results of an ecosystemic survey of the situation immediately before the hydrological works came into operation, i.e. while the forest and meadow ecosystems in particular were still under the influ-ence of uncontrolled flooding. In 1973 this flood-ing ceased. This allowed data to be assembled for a comparison of the ecological changes which followed an overall decrease in the amount of water available. (See W91-10299 thru W91-10308) available. (See W9 (White-Reimer-PTT) W91-10298

NATURAL CONDITIONS OF FLOODPLAIN FORESTS.

Brno Univ. (Czechoslovakia). F. Vasicek.

F. Vasicek. IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 13-29, 5 fig, 14 ref.

Descriptors: \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Forest ecosystems, \*Forest watersheds, Dyje River, Flood plain ecology, Flood plain management, Morava River, Riparian

The Central-European floodplain forests represent specific forest geobiocenoses, differing both phy-siognomically and ecologically from those existing in lowland and upland regions. Their flora and fauna have a specific composition related to ecotauna nave a specific composition related to eco-types formed on Quaternary river alluvia, regular-ly or occasionally inundated and affected, especial-ly in the first half of the growing season, by a high level of groundwater. The study area included south-Moravian floodplain forests growing in allu-via of the lower reaches of the Dyje and Morava rivers and in the region of their confluence. The altitude of the whole region ranges from 151 to 165 antitude of the whole region ranges from 151 to 165 m, and the gradient of both river beds is, on average, 0.3%. Much of the original forest has been changed into arable land and meadows. Nevertheless, the original forest still occurs in relatively large areas along both rivers, where regular flooding prevented agricultural activity. Ecosystems of the region are characterized by optimum temperature and humidity as well as by high re-serves of soil nutrients; these factors have favorserves of soin nurients; trees factors have favorable effects on the development of plant and animal populations, great biological abundance and rapid biogeochemical cycling. The main causes of man-made changes to the floodplain forests were the needs of agricultural production, the protection of buildings and agricultural land against floods, of buildings and agricultural land against floods, and the exploitation of timber for the needs of the population and industry. Ecologically, the strongest recent influences in the region have been extensive water-management and land-reclamation measures on the lower courses of the Dyje and Morava rivers. Assessing the ecological consequences of these measures and establishing suitable principles of management in the new situation is an important subject for present and future investiga-tions. (See also W91-10298) (White-Reimer-PTT)

RADIATION, TEMPERATURE AND RAIN-FALL REGIMES OF THE FLOODPLAIN FOREST ECOSYSTEM.

For primary bibliographic entry see Field 2B. W91-10300

SOIL CONDITIONS.

Brno Univ. (Czechoslovakia).
For primary bibliographic entry see Field 2G.
W91-10301

STRUCTURE AND BIOMASS OF THE HERB

Brno Univ. (Czechoslovakia). For primary bibliographic entry see Field 2I. W91-10302

SPECIES COMPOSITION AND BIOMASS OF PHOTOTROPHIC EDAPHON IN THE ECO-SYSTEM OF A FLOODPLAIN FOREST IN SOUTHERN MORAVIA.

For primary bibliographic entry see Field 21. W91-10303

PRIMARY PRODUCTION OF A GRASSLAND ECOSYSTEM OF FLOODPLAIN MEADOWS. For primary bibliographic entry see Field 2I. W91-10304

SOME PHYSIOLOGICAL PROCESSES IN THE ECOSYSTEM OF A FLOODPLAIN FOREST. Brno Univ. (Czechoslovakia). For primary bibliographic entry see Field 2D. W91-10305

ACTIVITY OF DECOMPOSERS AND PROCESSES OF DECOMPOSITION IN SOIL. For primary bibliographic entry see Field 2G. W91-10306

ENZYMATIC ACTIVITY OF THE SOIL UNDER A FLOODPLAIN FOREST AND ITS CONNECTION WITH THE BIOLOGICAL RECYCLING OF NUTRIENTS.

For primary bibliographic entry see Field 2G. W91-10307

CYCLING OF MINERAL NUTRIENTS. Brno Univ. (Czechoslovakia). For primary bibliographic entry see Field 2K. W91-10308

### 2I. Water In Plants

TIME- AND PH-DEPENDENT LEACHING OF IONS FROM DECIDUOUS AND CONIFEROUS

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 2B. W91-09362

GRAIN YIELD, STALK ROT, AND MINERAL CONCENTRATION OF FERTIGATED CORN AS INFLUENCED BY N P K. Illinois Univ., Urbana. Dept. of Agronomy. For primary bibliographic entry see Field 3F. W91-09400

INFLUENCE OF TEMPORARY FLOODING AT THREE GROWTH STAGES ON SOYBEANS GROWN ON A CLAYEY SOIL.

Arkansas Univ., Fayetteville. Dept. of Agronomy. H. D. Scott, J. DeAngulo, L. S. Wood, and D. J.

## Water in Plants—Group 21

Journal of Plant Nutrition JPNUDS, Vol. 13, No. 8, p 1045-1071, 1990. 5 fig, 4 tab, 23 ref.

Descriptors: \*Agriculture, \*Clays, \*Drainage, \*Flooding, \*Plant growth, \*Soil-water-plant relationships, \*Soybeans, \*Water resources managetionships, \*Soybeans, \*Water resources management, \*Waterlogging, Crop yield, Nutrient concentrations, Oxygen diffusion, Soil profiles, Soil types, Temporal distribution.

Knowledge of crop response to temporary water-logging is important in the development of effec-tive water management practices. A field study was conducted to determine the response of soywas conducted to determine the response of soy-bean (Glycine max (L.) Merr.) grown on a poorly drained, clayey soil to temporary flooding at three growth stages. The four treatments were soybean flooded for seven consecutive days at either V1, V4 or R2 growth stages at a flood height of 0.03 m above the soil surface and a well-watered control. above the soil surface and a well-waterte control. Flooding for seven consecutive days wetted but did not saturate the lower parts of the soil profile, possibly due to swelling by the montmorillonite clay and the subsequent sealing of the soil near the surface. In general Eh and oxygen diffusion rates decreased gradually during the flood, but increased decreased gradually during the flood, but increased as the soil dried with the removal of the flood water. Canopy heights and dry weights of the flooded soybeans were dependent on plant growth stage at flooding and time of measurement but were lower than the control. When flooded at the VI or V4 growth stages, concentrations of nitrogen and potassium in the above-ground plants were lower than the control after the flood. Three weeks after the flood water was removed, higher concentrations of these elements were noted en flooded at R2, concentrations of nitrogen and potassium were lower than in the control. Few differences were found in the plant concentrations of calcium, magnesium, manganese, iron, aluminum, and sodium in the plant due to flooding, but by the end of the growing season, concentrations of manganese, iron, and aluminum were higher in to manganese, non, and adminish were legiter in the R2 flooded soybeans than in the other treat-ments. Seed yield response of the soybeans de-pended on plant growth stage at flooding. The soybeans were particularly sensitive to the seven days of continuous flooding at the R2 growth stage. Values of relative seed yield were 88, 83 and 44% of the well watered-control for the VI, V4 and R2 growth stages, respectively. Differences in seed yield were found with cultivar and with cultivar + flood treatment. (Author's abstract) W91-09401

## CONTROL OF PLANT WATER POTENTIAL IN WATER STRESS STUDIES.

Minnesota Univ., St. Paul. D. W. Kidder, and R. Behrens. Weed Science WEESA6, Vol. 39, No. 1, p 91-96, January/March 1991. 10 fig, 1 tab, 20 ref.

Descriptors: \*Plant physiology, \*Plant water potential, \*Soil-water-plant relationships, \*Water stress, \*Weeds, Equilibration, Experimental design, Osmosis, Plant growth, Semipermeable mem-branes, Water potentials.

Weed seedlings were grown in a composite soil contained within a semipermeable membrane that allowed the development of consistent, reproducible levels of plant water stress. The water content of membrane units with a one cm cross section equilibrated most rapidly, within 3 to 5 days, with the external osmotic solution. The water potential water potential of green foxtail grown in plant water potential of green foxtail grown growth membrane units was curvilinearl to the external polyethylene glycol (PEG) osmotic solution water potential. This relationship permitted nondestructive estimation of plant water potential. Green foxtail shoot growth in membrane units was reduced by decreasing water potential of the external PEG osmotic solution and was completely arrested by high water stress induced by a minus 800 kPa external osmotic solution. The technique makes possible precise control and relatively rapid adjustment in the level and duration of plant water potential of seedlings and small plants. (Author's abstract) W91-09418

FOREST HYDROLOGIC RESEARCH IN CHINA

Beijing Coll. of Forestry (China). Dept. of Soil and Water Conservation.
For primary bibliographic entry see Field 2A.
W91-09733

# INTERACTION OF SALINITY AND TEMPERATURE ON THE GERMINATION OF CRAMBE.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
For primary bibliographic entry see Field 3C.
W91-09912

## SIMULATED GROWING-SEASON PRECIPI-TATION AND NITROGEN EFFECTS ON WINTER WHEAT YIELD.

Montana Agricultural Experiment Station, Hunt-ley, MT. Southern Agricultural Research Center. R. E. Engel.

Agronomy Journal AGJOAT, Vol. 83, No. 1, p 180-185, January/February 1991. 5 fig, 4 tab, 18

Descriptors: \*Available water, \*Crop yield, \*Fer-tilizers, \*Great Plains, \*Nitrogen, \*Precipitation, \*Soil water, \*Soil-water-plant relationships, \*Wheat, Cultivars, Sandy loam, Sprinkler irrigation. Temperature effects.

Available water (precipitation plus stored soil water) is the principal factor that determines wheat (Triticum aestivum) yield potential and response to N in the Northern Great Plains. Field studies were conducted in 1987 and 1988 to determine the interactive effect of water and available N on cultivars Redwin and Centurk winter wheat yield. Seven fertilizer N levels and a line-source sprinkler system created a wide range of N and simulated growing-season precipitation (SGSP) regimes on a Yegensandy loam (fine-loamy, mixed, Typic Agri-boroll). Wheat yield-N-SGSP functions revealed boroll). Wheat yield-N-SGSP functions revealed that yield and response to water were much greater in 1987 than 1988, when return from N was maximized (maximum economic yield or MEY). At 100, 200, and 300 mm SGSP, predicted MEY in 1987 averaged 2350, 4019, and 5434 kg/ha, respectively. In 1988, MEY was 9, 17, and 24% lower, respectively. High available N reduced yield from the maximum across all SGSP regimes in 1988, but the maximum across all SGSP regimes in 1988, but not in 1987. High temperatures during grain fill in 1988 (23.1 C, 4.7 C warmer than 1987), were likely 1988 (23.1 C, 4.7 C warmer than 1987), were likely the reason for differing yield-N-SGSP relations. Though Centurk yielded more than Redwin for most SGSP conditions, the N required for MEY or optimum N level (ONL) was greatly affected by cultivar. Due to less favorable growing conditions, the ONL was approximately 27% lower in 1988 than 1987. An acceptable fertilizer N strategy might be to raise the ONL level to 100 kg/ha at 100 mms growing search sensitivities the edited might be to raise the UNL level to 100 kg/ha at 100 mm growing-season precipitation, then adjust N upward 1 kg/ha for every 3 mm rise in available water. (Author's abstract) W91-09913

## CULTIVARS' RESPONSE FLOOD IRRIGATION OF CLAY SOIL. Agricultural Research Service, Stoneville, MS. Soybean Production Research Unit.

For primary bibliographic entry see Field 3F. W91-09914

## DIURNAL PHOTOSYNTHESIS CYCLE IN CAM AND NON-CAM SEASONAL-POOL AQUATIC MACROPHYTES.

Occidental Coll., Los Angeles, CA. Dept. of Biol-For primary bibliographic entry see Field 2H. W91-09917

# UNDERSTORY VEGETATION RESPONSE TO INCREASING WATER AND NITROGEN LEVELS IN A PINUS PONDEROSA FOREST IN NORTHEASTERN OREGON.

Oregon State Univ., Corvallis. Dept. of Rangeland

G. M. Riegel, and R. F. Miller.

Northwest Science NOSCAX, Vol. 65, No. 1, p 10-15, 1991. 3 fig, 3 tab, 28 ref.

Descriptors: \*Soil-water-plant relationships, \*Forest hydrology, \*Forestry, \*Oregon, \*Under-story vegetation, \*Pine trees, \*Nitrogen, Light, Growth, Biomass, \*Coniferous forests, Water re-

Competition for soil moisture has been proposed as the dominant environmental resource governing understory production in pine forests of eastern Oregon. Other studies have demonstrated that Oregon. Other studies have demonstrated that light and nitrogen may also be limiting understory growth. An experiment was conducted to assess the effects of water and nitrogen. A completely randomized block design experiment used three blocks and four treatments: (1) control, (2) water (pringted block). (3) nitrogen (ammonium nitrogen). blocks and four treatments: (1) control, (2) water (irrigated biweekly), (3) nitrogen (ammonium nitrate, 32% N: 50kg N/ha), and (4) water + nitrogen. At peak standing crop (June 26 through July 7) the water + nitrogen treatment produced 16 and 18% greater aboveground dry weight biomass then the sitrogen and 166%. than the nitrogen and water treatments and 36% more than the control treatments. Nitrogen and water treatments were 17 and 15% more productive than the control treatment. There was no relationship between light (PAR) measured at the center of each plot and light sensitive ozalid paper, and biomass production. Understory vegetation is significantly limited by both water and nitrogen in P. ponderosa forests of northeastern Oregon. (Author's abstract)

## INFLUENCE OF SOIL, PLANT AND METEOR-OLOGICAL FACTORS ON WATER RELA-TIONS AND YIELD IN HEVEA BRASILIEN-

Rubber Research Inst. of India, Kerala G. Gururaja Rao, P. Sanjeeva Rao, R. Rajagopal, A. S. Devakumar, and K. R. Vijayakumar. International Journal of Biometeorology IJBMAO, Vol. 34, No. 3, p 175-180, 1990. 4 fig, 2 tab, 10 ref.

Descriptors: \*Drought resistance, \*Meteorology, \*Rubber trees, \*Soil water, \*Soil-water-plant relationships, \*Transpiration, Leaves, Plant physiology, Plant water potential, Seasonal variation, Stomatal transpiration, Yield.

The influence of factors governing the soil-plantatmosphere system on components of water rela-tions and yield was studied in two clones of the rubber tree, Hevea brasiliensis, RRII 105 and RRII 118. Clonal variations were evident in yield and yield components and associated physiological pa-rameters in response to soil moisture status and rameters in response to soil moisture status and meteorological factors. Observations made during different seasons indicate variations in yield are attributed to differences in plugging index and initial flow rates, to the major yield components and variations in components of water relations as influenced by meteorological factors. The clone RRII 105 was fairly drought tolerant compared to RRII 118. RRII 105 responded well to dry weather through higher stomatal resistances, higher leaf water moteratials lowered transpirational water loss. water potentials, lowered transpirational water loss and lower relative transpiration ratios, while RRII 118 was susceptible to stress situations. (Author's abstract) W91-09953

## EFFECTS OF NATURAL DISTURBANCES ON WARM TEMPERATE RAINFORESTS SOUTH-EASTERN AUSTRALIA.

Melbourne Univ., Parkville (Australia). Dept. of

D. R. Melick, and D. H. Ashton. Australian Journal of Botany AJBTAP, Vol. 39, No. 1, p 1-30, 1991. 14 fig, 4 tab, 48 ref, 3 append.

Descriptors: \*Australia, \*Disturbance, \*Floods, \*Forest hydrology, \*Landslides, \*Rain forests, \*Species composition, \*Succession, Ecosystems, Moisture availability, Moisture content, Plant growth, Regeneration, Temperate zone.

The effects of fire, flood and landslide disturbances on the floristics and structure of some warm tem-

## Group 21-Water In Plants

perate rainforests in East Gippsland Australia, were investigated from 1983 to 1989. Subcommunities within these forests were delineated by the numerical analyses of floristic data. In moister sites, relatively undisturbed rainforest is dominated by Acmena smithii in association with Acronychia oblongifolia and Rapanea howittiana together with numerous vines and ferns. The size-class distributions of the major tree species indicate that these forests are regenerating. In riparian habitats, Tristaniopsis laurina tends to dominate due to its greater flood resistance whereas Pittosporum undulatum becomes prominent in edaphically drier sites. Within burnt rainforest, A. smithii and T. laurina have regenerated vegetatively but P. undulatum has been eliminated. In adjacent wet sclerophyll forests subsequent invasion by rainforest seedlings has occurred. In gorges, landslides may cause disturbance to various degrees and subsequent colonization is dependent upon both the site and the matrix of the material transposed. The status of the various subcommunities is related to the environmental gradients present, the modes of regeneration, and the types of primary and secondary successions initiated by the disturbances. (Author's abstract)

FIELD STUDY OF THE EFFECTS OF WATER DEPTH, ORDER OF EMERGENCE AND FLOWERING ON THE GROWTH OF TYPHA GLAUCA SHOOTS USING THE RICHARDS MODEL

MODEL.
Manitoba Univ., Winnipeg. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-10163

VEGETATION CHANGE IN A SEMI-ARID SUCCULENT DWARF SHRUBLAND IN THE EASTERN CAPE, SOUTH AFRICA. Rhodes Univ., Grahamstown (South Africa). For primary bibliographic entry see Field 2B. W91-10185

EFFECT OF ELEVATED ATMOSPHERIC CO2 ON GROWTH, PHOTOSYNTHESIS AND WATER RELATIONS OF SALT MARSH GRASS SPECIES.

Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology. For primary bibliographic entry see Field 5C. W91-10195

ROOT ADAPTATION TO SOIL WATERLOG-GING.

Hull Univ. (England). Dept. of Applied Biology. W. Armstrong, S. H. F. W. Justin, P. M. Beckett, and S. Lythe.

and S. Lythe.

Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 57-73, February 1991. 6 fig, 1 tab, 45 ref.

Descriptors: \*Plant growth, \*Plant physiology, \*Roots, \*Soil-water-plant relationships, \*Water-logging, \*Wetlands, Literature review, Mathematical models.

This review of root adaptation to soil waterlogging considers the ways in which the growth and development of roots affect their aeration and thereby influence the plant's ability to survive and compete in wetland conditions. Although plants often sucumb to soil waterlogging, at least two successful developmental rooting strategems can be identified and both involve anoxia avoidance: (1) superficial rooting; and (2) enhanced development of internal gas space. They survive presumably by exploiting chiefly the aerobic surface horizons, although in many cases aeration will be supplemented to some degree by internal transport. Usually, the roots which develop, or perhaps the only ones to survive, are very thin and this accords with the prences in root porosity depends on species, on root type and even on the stage of development of individual roots. Other adaptations involve aerenchyma development and rhizosphere conditions. Other aspects that need to be studied are the role of anaerobic metabolism in roots, their tolerance of

anoxia, and the dynamics of root and soil aeration. (Author's abstract) W91-10196

## STRUCTURE AND BIOMASS OF THE HERB

Brno Univ. (Czechoslovakia).

IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 171-238, 12 fig, 10 tab, 25 ref.

Descriptors: \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Forest ecology, \*Herbaceous plants, \*Riparian vegetation, Biomass, Litter, Seasonal variation.

The biomass and structure of the herb layer and their components under conditions of forest-type group Ulmeto-Fraxinetum carpineum were studied on a Czechoslovakian floodplain. Using analytical data, fitted curves of aboveground biomass, underground biomass, leaf-blade area, total assimilatory surface and other growth-analytical characteristics of approximately 50 taxa of herbs were calculated and plotted graphically, in their seasonal dynamics, with regard to the duration of the main phenophases. The spectrum of biological types in the period of maximum aboveground biomass consisted of 70% hemicryptophytes, 10% chamaephytes, 3% biennial therophytes and 10% annual therophytes. The leaf area index of the herb layer had its 1971 (flood) maximum at the end of June. Values of heat combustion of 1 g of dry matter of aboveground biomass ranged from 152,63 to 17,970 J in the 15 species under study. In 1972, the efficiency of solar energy fixation in the herb layer was, on average, 0.51 and 0.71% of aboveground and total (i.e. aboveground and underground) biomass, respectively. The water content in fresh biomass ranged from 72.2 to 94%. In 1972, the production of aboveground biomass was found in July (1,168 kg/ha). The annual sum of dead matter was (1,122 kg/ha. (See also W91-10298) (Author's abstract)

#### SPECIES COMPOSITION AND BIOMASS OF PHOTOTROPHIC EDAPHON IN THE ECO-SYSTEM OF A FLOODPLAIN FOREST IN SOUTHERN MORAVIA. F. Hindak.

His: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 239-249, 3 fig, 1 tab, 11 ref.

Descriptors: \*Algae, \*Czechoslovakia, \*Soil algae, \*Flood plains, \*Riparian vegetation, \*Wetlands, \*Flood plain forests, \*Chlorophyll a, Hydrogen ion concentration, Biomass, Chlorophyta, Diatoms, Cyanophyta, Biomass.

Species composition and algal biomass were studied on a floodplain in Czechoslovakia. One hundred and three taxa of blue-greens and algae were recorded in soil samples; green algae and diatoms predominated. A modified method of estimation of chlorophyll a content in the soil was used for calculation of algal biomass. The biomass of soil blue-greens and algae was estimated according to a modified method which was based on the chlorophyll content in the soil. When calculating the chlorophyll a content, no correction for phaeophytins was carried out. Chlorophyll content ranged from 34.7 to 368.6 mg/g in the 1-10 cm soil layer. The curve of chlorophyll distribution in the soil (0-10 cm) had a hyperbolic course; the highest chlorophyll content was found in the 0-1 cm surface layer. Presuming a 1% chlorophyll a content in the ymatter of the dominant algae, the soil biomas varied from 34.7 to 368.6 kg DM/ha. The water content in the soil ranged from 9.8 to 47.5%; pH-values ranged from 6.4 to 8.7. Application of the method of chlorophyll estimation in water, has some advantages and disadvantages. Species composition and the total production of edaphon bio-

mass were studied within one year only; they indicate the position at one moment only. On the other hand, when this methodology is strictly observed, the results obtained are relatively accurate and reproducible. In addition, the method is not too time-consuming and the soil samples may be analyzed immediately after being taken from the study area. (See also W91-10298) (White-Reimer-PTT)
W91-10303

## PRIMARY PRODUCTION OF A GRASSLAND ECOSYSTEM OF FLOODPLAIN MEADOWS, J. Lesak.

J. Lesak.

IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 275-288, 8 fig, 2 tab, 6 ref.

Descriptors: \*Czechoslovakia, \*Flood plaine ecology, \*Flood plains, \*Grasslands, \*Groundwater level, \*Meadows, \*Riparian vegetation, Biomass, Seasonal variation.

The primary production of the grassland ecosystem of floodplain meadows in Czechoslovakia was studied in relation to ecological and anthropogenic factors. Stands of a floodplain meadow were selected at the beginning of the vegetative period of 1969, on the basis of a botanical evaluation of each stand in relation to the study area of the floodplain forest. A close relationship between ecological factors and their effect on the formation of the aboveground biomass was demonstrated. Soil moisture, affected by the level of groundwater, was decisive for acquiring the maximum yields of above-ground biomass with a given intensity of solar radiation and nutrition. As soon as the level falls below 6.0 mf from the soil surface, a considerable decrease in biomass formation occurs. This region of floodplain meadows is an arid one, where the total sum of precipitation and its distribution is not sufficient for the successful development and yield-capacity of this meadow community. Therefore, the production capacity of these plots, where the participation of Alopecurus pratensis is predominant, is conditioned by an increased level of groundwater and/or floods at the beginning of the development of vegetation, and also in the summer season. This is the reason why the regulation of rivers should not be allowed to prevent flooding completely, as this causes a considerable decrease in biomass production, even in stands fertilized with high doses of nutrients. (See also W91-10298) (White-Reimer-PTT)

W91-10304

## SOME PHYSIOLOGICAL PROCESSES IN THE ECOSYSTEM OF A FLOODPLAIN FOREST. Brno Univ. (Czechoslovakia).

For primary bibliographic entry see Field 2D. W91-10305

#### REMOTE SENSING OF TERRESTRIAL ECO-SYSTEM STRUCTURE: AN ECOLOGIST'S PRAGMATIC VIEW.

Commonwealth Scientific and Industrial Research Organization, Lyneham (Australia). Div. of Wildlife and Rangelands Research.

For primary bibliographic entry see Field 7B. W91-10375

#### ESTIMATING TERRESTRIAL PRIMARY PRO-DUCTIVITY BY COMBINING REMOTE SENS-ING AND ECOSYSTEM SIMULATION,

Montana Univ., Missoula. School of Forestry. For primary bibliographic entry see Field 7B.

#### EVALUATION OF CANOPY BIOCHEMISTRY. Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space.

For primary bibliographic entry see Field 7B. W91-10380

# Erosion and Sedimentation—Group 2J

REMOTE SENSING OF SPATIAL AND TEM-PORAL DYNAMICS OF VEGETATION. Commonwealth Scientific and Industrial Research Organization, Lyncham (Australia). Div. of Wild-

life and Ecology.
For primary bibliographic entry see Field 7B.
W91-10383

PROCEEDINGS OF: SOUTH TEXAS IRRIGATION CONFERENCE, For primary bibliographic entry see Field 3F. W91-10445

MICROSPRAYER IRRIGATION FOR COLD

PROTECTION.
Texas A and M Univ., Weslaco. Agricultural Research and Extension Center.
For primary bibliographic entry see Field 3F.
W91-10460

### 2J. Erosion and Sedimentation

PROBABILITY OF SEDIMENT YIELDS FROM SURFACE EROSION ON GRANITIC ROAD-FILLS IN IDAHO.

Intermountain Forest and Range Experiment Station. Boise. ID.

uon, Bolse, ID. W. F. Megahan, S. B. Monsen, and M. D. Wilson. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 53-60, January/March 1991. 2 fig, 2 tab, 32 ref.

Descriptors: \*Environmental effects, \*Erosion control, \*Idaho, \*Model studies, \*Roads, \*Sediment erosion, \*Sediment yield, Erosion, Road construction, Rock fill, Runoff, Sediment control, Simulation models, Statistical analysis, Stream deg-

A series of 29 bordered plots, 1.8 m wide by 4.6 m long, was used to measure sediment yields from granitic roadfills on forest roads in the mountains of Idaho. Slope gradients on the plots ranged from 34 to 41 deg. Sediment yield data for the snowfree season were collected for 3 yr following road construction. Various site factors were tested by regression analysis for their effects on sediment regression analysis for their effects on sediment yield, but only ground cover density and snowfree period rainfall erosivity were statistically significant. Analysis of 22 yr of snowfree period rainfall erosivity data showed that erosivity was lognormal distributed, and established the parameters for the probability density function. These data, coupled with the prediction equation from the regression model, were used in a Monte Carlo simulation model to define the probability of occurrence of sediment yields from granitic roadfills, given various levels of ground cover density. A prediction equation based on ground cover density and the snow free period erosivity index explained and the snow free period erosivity index explained 55% of the variance in sediment yields. Recently published studies that update the slope gradient and slope length components of the Universal Soil Loss Equation were then used to extrapolate the results of the present study to all lengths and gradients of granitic roadfills. Roads associated with forest management activities were found to be the primary cause for serious downstream cumu tive effects of sedimentation in the Idaho Batholith. Erosion control treatments such as the application of mulches, must accomplish site protection during the high erosion period before vegetation has had a chance to become established. (Doyle-PTT) W91-09333

DOWNSTREAM EFFECTS OF TIMBER HAR-VESTING ON CHANNEL MORPHOLOGY IN ELKS RIVER BASIN, OREGON. Colorado Univ., Boulder. Inst. of Arctic and Alnine Research

Alpine Research.

For primary bibliographic entry see Field 4C. W91-09334

RADIOELEMENT DISTRIBUTION IN RIVER, BEACH, AND OFFSHORE AREAS AND THEIR SIGNIFICANCE TO CHAVARA PLACER DE-POSIT, SOUTHERN KERALA COAST OF

Centre for Earth Science Studies, Trivandrum

T. N. Prakash, G. K. Raju, and M. Prithviraj. Geo-Marine Letters GMLEDI, Vol. 11, No. 1, p 32-38, 1991. 6 fig, 1 tab, 22 ref.

Descriptors: \*Geochemistry, \*India, \*Marine mining, \*Minerals, \*Model studies, \*Placer mining, \*Radioactivity, \*Sediment transport, \*Sedimentation, Coastal waters, Geomorphology, Littoral zone, Longshore currents, Mathematical models, Minerals, Particle size, Radioactive tracers, Rivers, Seasonal variation, Suspended sediments.

The placer concentration at Chavara was investi-The placer concentration at Chavara was investi-gated through detailed radioclement and heavy mineral distributions in four southern Kerala rivers supported with grain size analyses of the beach and inner shelf zone of the Quilon coast. The study area encompasses the beach and inner shelf region of the Quilon coast and four south Kerala rivers (Neyyar, Karamana, Vamanapuram, Kallada). The radioclement and heavy mineral distribution in river, beach and innershelf areas of the southern Kerala coast is related to placer mineral concentra-tion on the beaches at Chavara, Southern Kerala rivers (Neyyar, Karamana and Vamanpuram) transport higher amounts of radioactive elements than the larger Kallada River due to higher radio-active minerals in the hinterland rocks. Coastal active minerais in the innteriand rocks. Coastail configurations and the seasonal longshore current pattern seem to control along-shore distribution of minerals. The proposed model for placer concentration suggests that the energy difference and seasonal current direction along this coast is important. The three factors responsible for radioactive. tant. The three factors responsible for radioactive tant. The three factors responsible for radioactive mineral distribution in rivers are morphology, structure, and hinterland geology. The results show that the littoral processes and the coastal configuration play a more important role in the concentration of heavy metals at Chavara than the proximity of source. (Brunone-PTT) W91-09379

#### CHANNEL-FORMING EFFECT OF FLOODS AND FRESHETS.

I. F. Karasev. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 429-434, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 9-12, July 1990. 2 fig, 9 ref.

Descriptors: \*Channel erosion, \*Channel flow, \*Channel morphology, \*Floods, \*Geomorphology, \*Model studies, Erosion, Estimating equations, Flood plains, Flow, Historic floods, Mathematical models, Valleys.

The transformation of river channels occurs con-The transformation of river channels occurs con-tinuously under conditions of varying water dis-charge. Mathematical methods are presented for estimating channel-forming, or dominant, dis-charges. Apart from dominant discharges, the other higher, particularly historic, floods and freshets determine the general form of the channel and, to a considerable extent, the river valley, such as the position of floodplain lands and channel as the position of floodplain lands and channel storages, and the spacing of pools and riffles. The viability of the morphological consequences of rare but high floods and freshets must be explained by the cumulative effect of their action on the channel, as a result of which the earlier developed microforms of the channel, which changed little under the action of other, lower, floods and fresh-ets, are kept during each repeat of the historic situation. At the same time, during discharges close to the maximum possible, a radical restructuring of the mesoforms of the channel and floodplain occurs, such as erosion of the banks and sand waves, straightening of meanders, and formation of floodplain channels. Thus, each type of discharge nooupiam channels. Thus, each type of discharge has a different potential of acting on the channel and floodplain. Engineering measures undertaken during regulation of channels and floodplains must be directed at the characteristic states of flow dominant, floodplain-forming, and channel-transforming discharges. (Doria-PTT)
W91-09456

RIDGE HYDRAULIC RESISTANCE OF TURBID CHANNEL FLOWS.

For primary bibliographic entry see Field 8B. W91-09460

ALLUVIAL RIVER BED TRANSPORT PROC-ESS WITH GRADED MATERIAL.

California Univ., Berkeley. H. W. Shen, and X. C. Rao.

H. W. Shen, and A. C. Rao.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-111559/
AS. Price codes: A04 in paper copy, A04 in microfiche. Final Report, April 1990. 55p, 17 fig. 3 table, 30 ref. USGS Contract No. 14-08-0001-G1319.
USGS Pariest No. G1320. USGS Project No. G1319.

Descriptors: \*Deposition, \*Mathematical models, \*Model studies, \*Sediment transport, \*Settling velocity, Bed layer, Einstein bed load function, Open-channel flow, Sediment size, Sedimentation.

A theoretical model was developed to describe the deposition distribution of solid sediment particles. This model agrees with experimental data collected from this study. An attempt was made to search ed from this study. An attempt was made to search for a single representative sediment size to be applied to existing sediment transport rate predic-tive equations. A new regression model was devel-oped based on 1151 sets of existing equations. The main contribution from this study was to develop a sediment respect for an existing rediment. sediment transport for non-uniform sediment sizes based on the Einstein bed load function. The thickoased on the Emissem bed load runction. The thick-ness of the bed layer was related to the characteris-tic size of a sediment mixture and the thickness of the viscous sub-layer of the flow as well. A hiding function was established by recognizing that the finer particles move faster than the coarser ones within the bed layer. (Shen-U.C.A, Berkely) W91-09472

SEDIMENT TRANSPORT IN THE LOWER PUYALLUP, WHITE AND CARBON RIVERS OF WESTERN WASHINGTON. Geological Survey, Tacoma, WA. Water Re-

W. G. Sikonia

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4112, 1990. 204p, 31 fig. 17 tab, 26 ref.

Descriptors: \*Bed load, \*Carbon River, \*Puyallup River, \*Sediment transport, \*Suspended load, \*Suspended sediments, \*Washington, \*White River, Channel erosion, Channel scour, Computer models, Deposition, Gravel, Hydraulic models, Mathematical models, Model studies, Particle size, River beds, Sediment concentration, Sediment control, Sediment discharge, Sediment load, Sedi-

Three alternative approaches for managing sediment deposition on the lower Puyallup, White, and Carbon Rivers of western Washington were compared by using a computer model of sediment transport. The three courses of action were to continue gravel mining by the procedure of scaling gravel bars, to install sediment traps, or not to intervene at all with sediment control measures on the river system. Measured cross sections, hydro-graphs, and sediment data from the period July-August 1984 to March 19, 1986, provided data for input and verification of computer model Hydro-logic Engineering Center-6. Cross-section surveys and computer model results both indicated that scour rather than deposition was taking place throughout much of the study area. Non-interven-tion thus would appear to be the most appropriate of the three alternatives for these degrading reaches. Gravel and coarser material as well as sand and finer material were deposited locally. Gravel deposition occurred at modeled rates of 1 Gravel deposition occurred at modeled rates of 1 to 3 cu yds/foot of river distance, per year, at several locations on the three rivers. These specific locations could be considered as potential river reaches for gravel bar scalping operations. To maintain bed elevations, the long-term average rate of gravel removal by scalping should equal the long-term average rate of deposition at the specific location. Sediment traps were shown to be an effective but inefficient course of action for removal of sand and finer material. Model results indicating

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ed that sediment traps affected gravel transport only near the traps themselves. (USGS) W91-09518

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME I: EROSION MODEL FOR DYNAMIC RILL NET-WORKS, PART A-INTRODUCTION AND OVERVIEW, PART B-EROSION MODEL DE-VELOPMENT.

Kentucky Univ., Lexington. Dept. of Agricultural

Rentucky Univ., Lexington. Dept. of Agricultural Engineering.

D. E. Storm, B. J. Barfield, and L. E. Ormsbee.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-125351/AS. Price codes: A07 in paper copy. A07 in microfiche. Kentucky Water Resources Research Institute, Lexington, Research Report No. 178, August 1990. 121p. 29 fig. 1 tab, 171 ref. USGS Contract No. 14-08-0001-G1147.

Descriptors: \*Erosion, \*Erosion control, \*Erosion models, \*Erosion rates, \*Model studies, \*Rill eromodels, \*Erosion rates, \*Model studies, \*Rill erosion, \*Sedimentation rates, Flow networks, Hydrology, Rills, Sedimentation, Sedimentology.

A dynamic erosion model was developed based on fundamental concepts of hydrology, sedimentology and probability. The model predicts erosion rates for varying surface conditions and will ultirates for varying surface conditions and will uni-mately be used to evaluate new and existing tillage systems without requiring extensive apriori field measurements. In addition, the dynamic erosion model can be used to assess the impact of density, surface roughness, channel network development and numerous other erosion sub-processes on sediment yield. The dynamic erosion model contains a deterministic runoff and erosion component applied to a stochastically generated random surface. The random surface is generated using a defined random roughness and correlation length for a specified covariance function. The resulting flow specinical covariance function. The resulting flow networks are defined with a digital elevation model applied to the generated surface. The ero-sion component models interrill erosion delivered to the flow network, and rill erosion based on shear excess principles. In addition, rill geometry for a rectangular cross-section is based on flow conditions, soil properties and surface geometry. (See W91-09520 and W91-09521) (USGS) W91-09519

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME II: HYDROLOGIC MODEL FOR DYNAMIC RILL NETWORKS.

Kentucky Univ., Lexington. Dept. of Civil Engi-

neering.
L. E. Ormsbee, G. E. Blandford, J. S.
Montgomery, and L. B. Terrell.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-125369/
AS. Price codes: A08 in paper copy, A08 in microfiche. Kentucky Water Resources Research Institute, Lexington, Research Report No. 179, August
1990. 160p, 32 fig. 12 tab, 37 ref, 5 append. USGS
Contract No. 14-08-0001-G1147.

Descriptors: \*Channel routing, \*Computer models, \*Hydrologic models, \*Infiltration rate, \*Model studies, \*Rill erosion, Channel erosion, Erosion models, Finite element method, Infiltration.

A comprehensive model has been developed for A comprehensive model has been developed for use modeling in the hydrologic response of rill network systems. The model, which is called HY-MODRIN, is composed of both a hydrologic runoff component and a hydraulic channel routing component. The hydrologic component of the model uses a Green Ampt infiltration approach linked with a nonlinear reservoir runoff model. The channel routing component of the model is based on a finite element solution of the diffusion wave equations. In order to account for backwater effects the model employs a dual level iteration scheme. The model may be used in either a stand alone mode or as a part of a comprehensive integrated rill erosion model. In the latter case, the hydrologic data for the rill network and the associated interrill flow areas is provided by a geographic-hydrologic interface model called GHIM. This

model accepts data from a digital elevation model and translate it into a form compatible with the hydrologic model. This report contains the theoretical development and operating instructions for both GHIM and HYMODRIN. (See W91-09519 and W91-09521) (USGS) W91-09520

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS. VOLUME HI: SIMULATION OF RANDOM RILL NETWORK GEOMETRIES ON AGRICULTURAL SOILS. Kentucky Univ., Lexington. Dept. of Civil Engi-

neering.
D. J. DeJolsvay, B. Data, G. Tayfur, M. L.
Kavvas, and B. J. Barfield.
Available from National Technical Information Available from National Technical Information Service, Springfield, VA 22161 as PB91-122617/ AS. Price codes: A07 in paper copy, A07 in microfiche. Kentucky Water Resources Research Institute, Lexington, Research Report No. 180, November 1989. 123p, 46 fig. 2 tab, 16 ref. USGS Contract No. 14-08-0001-G1147.

Descriptors: \*Agricultural watersheds, \*Model studies, \*Rill erosion, \*Simulation analysis, \*Soil erosion, \*Stochastic hydrology, Erosion models, Rills. Soil surfaces.

Experiments were carried out with a rainfall simu-Experiments were carried out with a familiat similator on a sloping agricultural plot 15 ft by 72 ft in dimension, with a slope of six percent. The experimentally observed rill geometries were recorded and the digital information was stored in disks for computer usage. A number of statistical parameters were estimated using the digitized samples of these observed rill networks. The statistics include spa-tially varying occurrence rates of the first order trainy varying occurrence rates of the institutes branching points, conditional occurrence rates of the second and higher order branching points, lengths of the branches, angular orientation of the branches and the configuration of each segment of the rill network. Using the occurrence rate and the locations of the observed branching points a set of branching rogists, were generated. The actival branching points were generated. The actual number of branching points and their locations are determined from a doubly stochastic Poisson random field. The path of the rills between the generated junction points, and the fingertip branches are simulated by fitting a sinusoidal tra-jectory to the observed branch geometries. The coefficients defining the sinusoidal trajectory becoefficients defining the sinusoidal trajectory be-tween generated junction points were sampled from a fitted multivariate normal distribution to account for the correlation between the estimated coefficients. The digitized path of the observed rill network branches between two consecutive branching points make up the sample set of the nonlinear curves to be fitted by nonlinear regres-sion. The same approach was used for the rill sion. The same approach was used for the rill segments between the last branching point and the tip of that branch. The straight line for this fingertip branch is a randomly assigned length based on the frequency histogram for that order of branches. (See W91-09519 and W91-09520) branches. (USGS) W91-09521

CONCENTRATIONS OF METALS IN BED MA-TERIAL IN THE AREA OF CONGAREE SWAMP NATIONAL MONUMENT AND IN WATER IN CEDAR CREEK, RICHLAND COUNTY, SOUTH CAROLINA.

Geological Survey, Columbia, SC. Water Re-

For primary bibliographic entry see Field 5B. W91-09533

MINERALOGICAL CORRELATION OF SUR-MINERALOGICAL CORRELATION OF SUR-FICIAL SEDIMENT FROM AREA DRAIN-AGES WITH SELECTED SEDIMENTARY IN-TERBEDS AT THE IDAHO NATIONAL ENGI-NEERING LABORATORY, IDAHO. Geological Survey, Idaho Falls, ID. Water Re-

sources Div R. C. Bartholomay.

Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4147, Sept. 1990. 18 p, 5 fig, 3 tab, 13 ref. Contract No.

DE-AI07-81ID12306. Project No. ID-165.

Descriptors: \*Idaho, \*Idaho National Engineering Laboratory, \*Mineralogy, \*Sediments, Data collections, Sedimentology, Stratigraphy.

The U.S. Geological Survey's project office at the INEL (Idaho National Engineering Laboratory), in cooperation with the U.S. Department of Energy, used mineralogical data to correlate surfi-Energy, used mineralogical data to correlate surri-cial sediment samples from the Big Lost River, Little Lost River, and Birch Creek drainages with selected interbed core samples taken from test holes at the RWMC (Radioactive Waste Manage-ment Complex), TRA (Test Reactors Area), ICPP (Idaho Chemical Processing Plant), and TAN (Test Area North). Correlating the mineralogy of a particular present-day drainage area with a particular sedimentary interbed provides information on historical source of sediment for interbeds in and near the INEL. Mineralogical data indicates that surficial sediment samples from the Big Lost River drainage contained a larger amount of feldspar and drainage contained a larger amount of reliaspar and pyroxene and a smaller amount of calcite and dolomite than samples from the Little Lost River and Birch Creek drainages. Mineralogical data from sedimentary interbeds at the RWMC, TRA, and ICPP correlate with surficial sediment of the present day Big Lost River drainage. Mineralogi-cal data from a sedimentary interbed at TAN correlate with surficial sediment of the present day Birch Creek drainage. (USGS) W91-09536

WEPP: MODELING FOR THE USER.

National Soil Erosion Lab., West Lafayette, IN. For primary bibliographic entry see Field 7C.

SEDIMENTATION.

Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry. S. E. Jorgensen.

IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 109-124. 5 fig. 2 tab, 39 ref.

Descriptors: \*Ecosystems, \*Mass transfer, \*Model studies, \*Sediment transport, \*Sedimentation, \*Suspended solids, Flow pattern, Kinetics, Phyto-plankton, Settling velocity, Water quality.

The processes of sedimentation and settling are of great importance in ecological modeling, since they account for significant mass transfer from water to sediment. Consequently, many models need to include a proper description of sedimenta-tion. It is difficult to account for the influence of the hydrological flow pattern on the sedimentation process. Therefore, theoretical approaches based upon physical considerations should almost always be accompanied by the use of sediment traps and direct or indirect measurements of the increase of sediment per unit time for the determination of net sedimentation rates. Removal by settling is most often described by a first order reaction. A simple first-order reaction scheme for sedimentation with first-order reaction scheme for sedimentation with the addition of the temperature influence is a sufficient description in most cases. As long as changes in the ecological structure are not included in the model, this relatively simple approach seems to give a level of complexity to sedimentation submodels which is compatible with the complexity of most other submodels. (See also W91-09611) (Korn-PTT) W91-09616 W91-09616

SEDIMENT-WATER EXCHANGE MODELS, Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.

For primary bibliographic entry see Field 7C. W91-09627

ABSENCE OF CAESIUM-137 FROM RECENT SEDIMENTS IN EASTERN AUSTRALIA--INDI-CATIONS OF CATCHMENT PROCESSES, Sydney Univ. (Australia). Dept. of Geography.

# Erosion and Sedimentation—Group 2J

P. Bishop, B. Campbell, and C. McFadden. Catena, Vol. 18, No. 1, p 61-69, February 1991. 2 Catena, Vol. 18, fig, 1 tab, 20 ref.

Descriptors: \*Australia, \*Cesium radioisotopes, \*Dating, \*Isotope studies, \*Paleohydrology, \*Sedimentation, Alluvial deposits, Catchment areas, Cutoffs, Deposition, Erosion, Fluvial sediments,

Sediment and soil containing the isotope cesium-137 (137-Cs) are generally understood to have been sub-aerially exposed within the last 35 to 40 years. The horizon of first appearance of 137-Cs in sedi-mentary deposits in Australia is equated with the mid-1950s, the time of first appearance of the iso-tope in Australia. Some sediments, however, which are known to have been deposited in alluvi-al cutoffs incer the mid-1950s do not contain the all cutoffs since the mid-1950s do not contain the isotope. This is interpreted as resulting from the high magnitude of the events which entrained and deposited the sediment. The sediment was eroded from sub-surface sites, and deposited and buried rapidly, thereby preventing the adsorption of the isotope. The data indicate that 137-Cs should be used very cautiously as a dating tool in settings where a good knowledge of the fluvial and sedimentological events accompanying the emplace-ment of the sediments is not available. (Author's

FIELD STUDY ON TOPOGRAPHICAL AND TOPSOIL EFFECTS ON RUNOFF GENERA-

Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie. For primary bibliographic entry see Field 2E. W91-09693

INSTRUMENT SYSTEM FOR PROFILING SUSPENDED SEDIMENT, FLUID, AND FLOW CONDITIONS IN SHALLOW MARINE ENVI-

Washington Univ., Seattle. School of Oceanography. For primary bibliographic entry see Field 7B.

STUDY OF RIVER CHANNEL PATTERN IN-FORMATION RECORDED BY GRAIN SIZE PARAMETERS OF FLUVIAL SEDIMENT.

Academia Sinica, Beijing (China). Inst. of Geogra-

Earth Surface Processes and Landforms ESPLDB, Vol. 16, No. 2, p 129-142, March 1991. 12 fig, 2 tab, 10 ref.

Descriptors: \*Alluvial channels, \*Alluvial deposits, \*Channel morphology, \*China, \*Fluvial sediments, \*Geomorphology, \*Particle size, Bed load, Channel flow, Paleohydrology, Sediment load,

River channel pattern may be regarded as the outcome of streamflow, sediment load, and channel boundary conditions, as can the grain size distribution of bed material. It may therefore be expected that connections should exist between river channel pattern characteristics and the corresponding river bed material grain size parameters. Using data from some Chinese rivers, an attempt Using data from some Chinese rivers, an attempt has been made to express these connections quantitatively by using statistical methods. The work demonstrates that the river's bed load can be related to the percentage of the traction subpopulation of the bed material shown by the probabilistic plot of grain size parameters of rivers and their channel geometry such as channel width-depth ratio and channel sinuosity. For instance, the higher the ratio of the traction to suspension subpopulation in bed material, the more sinuous, more shallow, and wider the river channel would be. Furthermore, a discrimination function has been given to distindiscrimination function has been given to distin-guish between meandering and wandering braided rivers. If the existence of these relationships can be supported by data from more rivers in other regions, then paleoriver channel geometry and its channel pattern character can be postdicted from

fluvial sediment grain size parameters of the pa-leoriver. This would open a new way to recon-struct the physicogeographical environment in which paleorivers developed. (Author's abstract) W91-09699

SPECTRAL RESPONSE OF SUSPENDED SEDIMENTS IN WATER UNDER CONTROLLED CONDITIONS.

Jawaharlal Nehru Univ., New Delhi (In School of Environmental Sciences. For primary bibliographic entry see Field 7B. W91-09748 New Delhi (India).

CHEMICAL SUITABILITY OF SUBSTRATES FOR WALLEYE EGG DEVELOPMENT IN THE LOWER FOX RIVER, WISCONSIN.

Michigan Technological Univ., Houghton. Dept. of Biological Sciences. For primary bibliographic entry see Field 5C. W91-09767

CHANGES IN BIOTIC INTEGRITY OF A RIVER IN NORTH-CENTRAL TENNESSEE. Tennessee Technological Univ., Cookeville. Dept.

of Biology. For primary bibliographic entry see Field 4C. W91-09768

EFFECT OF SPARSE VEGETATIVE COVER ON EROSION AND SEDIMENT YIELD.
R. D. Rogers, and S. A. Schumm.
Journal of Hydrology JHYDA7, Vol. 123, No. 1/
2, p 19-24, February 1991. 3 fig, 10 ref. U.S. Army
Research Office grant DAAG29-84-K-0189.

Descriptors: \*Erosion control, \*Erosion rates, \*Sediment yield, \*Soil erosion, \*Vegetation effects, Cover crops, Land management, Slope pro-

An understanding of the effectiveness of vegetation in protecting the ground surface against ero-sion is not only of scholarly interest, but it can be of great practical value in land management and agriculture. An experimental study was made of the effects of changing vegetative cover from 43% to zero on a 10% slope. It was demonstrated that sediment yield increases rapidly as vegetative cover decreases from 43 to 15%, but with less than 15% vegetative cover, the rate of increase of sediment yield diminishes markedly. Therefore, the relation best describing the effect of vegetative cover on sediment yield is neither linear nor exponential, and these results indicate that less than 15% vegetative cover is ineffective in retarding erosion. Therefore, efforts to reduce erosion by slightly increasing vegetation density in the dry-lands of the world will also be ineffective. (Author's abstract) W91-09777

MULTIPLE MODES OF ADJUSTMENT IN UNSTABLE RIVER CHANNEL CROSS-SEC-

Geography and Planning.
J. D. Phillips.
Journal of Hydrology JHYDA7, Vol. 123, No. 1/2, p 39-49, February 1991. 1 tab, 26 ref.

Descriptors: \*Channel flow. \*Channel morphology, \*River flow, \*Sediment transport, \*Stream discharge, \*Unstable channels, Cross-sections, Flow characteristics, Hydraulic properties, Model stud-

Previous studies of the ways in which changing Previous studies of the ways in which changing flows are accommodated by stream channels (atastation hydraulic geometry) suggest that there may be multiple modes of adjustment-qualitatively different ways in which hydraulic variables respond to changes in imposed flow. Extremal hypotheses for alluvial channel behavior were analyzed to determine whether multiple modes of adjustment (MMA) are inherent in those hypotheses. After showing the fundamental equivalence of the various extremes, it was demonstrated that there are

essentially infinite combinations of flow width, depth, and energy grade slope which can satisfy a given extremum. It was also shown that hydraulic variables may not always respond to changing discharge in the expected direction. These represent the necessary conditions for the existence of MMA. Data from 22 measured discharge changes at four different cross-sections on three different cross-sections on the cross-sections of the cross-sections on the cross-sections of the cross-section at four different cross-sections on three different alluvial rivers showed 11 qualitatively different modes of adjustment. It was found, for example, that there are an infinite number of combinations of width, depth, hydraulic radius, slope, and velocity which can produce a given maximum friction factor. This suggests that models of channel re-sponse to changing flow must be based on knowl-edge of the relative response time of hydraulic variables under a range of flow conditions. (Au-thor's abstract) W91-09779

MAGNITUDE AND FREQUENCY OF DEBRIS

Maryland Univ., College Park. Dept. of Civil En-

gineering.
P. A. Johnson, R. H. McCuen, and T. V. Hromadka.

Journal of Hydrology JHYDA7, Vol. 123, No. 1/ 2, p 69-82, February 1991. 1 fig, 5 tab, 17 ref.

Descriptors: \*Debris flow, \*Erosion, \*Flood flow, \*Flow models, \*Sediment transport, California, Civil engineering, Drainage engineering, Flow equations, Flow index, Model studies.

Debris flows periodically result in the loss of lives and property. Engineering structures designed to control debris flows are often inadequate because of lack of knowledge of the magnitude of debris events. A study was performed to develop a method that could be used to estimate the magnimethod that could be used to estimate the magnitude and frequency of debris flows. The database for the study included 29 watersheds in the Los Angeles, California, area, with drainage areas < 3 equare miles. Assuming a log-normal distribution, prediction equations for 2-, 5-, 10-, 25-, 50-, and 100-year return periods were developed as a function of rails ratio, hypermetric index the interest. to year return perious were developed as a func-tion of relief ratio, hypsometric index, the interval between burns, and drainage area. Principal com-ponents and correlation analyses were used to cali-brate the model. The index flood method is com-monly used in water flood planning, where the discharge is computed for the index flood (fre-quently the 2-year discharge) with a regression equation and then discharges can be computed for other return periods using a set of multiplication constants called index ratios. It was found that, using the mean values of the predictor variables, using the mean values of the predictor variables, the computed index ratios were approximately equal to the return period for return periods up to the 50-year event. These index ratios should only be used for planning purposes. Index ratios for water floods are typically between 1.5 to 5.0; the ratios for debris flows are much higher, ranging from 5 to 80. The prediction equations can be used to estimate the magnitude of debris flows for ungaged watersheds where estimates are required for debris basin and channel design, protection of culdebris basin and channel design, protection of cul-verts and roads, land use planning, and zoning and establishing insurance rates. (See also W91-09782) (Fish-PTT) W91-09781

DEBRIS BASIN POLICY AND DESIGN.

Maryland Univ., College Park. Dept. of Civil Engineering. P. A. Johnson, R. H. McCuen, and T. V.

Hromadka.

Journal of Hydrology JHYDA7, Vol. 123, No. 1/ 2, p 83-95, February 1991. 2 fig, 3 tab, 13 ref.

Descriptors: \*Debris basins, \*Drainage engineering, \*Hydraulic engineering, \*Sediment control, Design criteria, Drainage programs, Hydraulic design, Watershed management.

Debris flows cause considerable property damage and loss of life. The debris basin is a widely used control alternative, for which accurate design methods are not available. Thus, there is a need for systematic design procedure, as well as a practi-

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cal basis for establishing policy elements. A design procedure that accounts for seasonal volumes of debris has been developed. The choice of the design return period and burn interval, both of which are important policy elements, is a function of the hazard level associated with failure. The monitoring and maintenance of debris basins are also important policy elements. The frequency of monitoring a basin to ensure adequate storage is a function of the potential hazard presented by a debris flow to the area downstream of the basin, as well as the precipitation, the frequency of burning debris flow to the area downstream of the basin, as well as the precipitation, the frequency of burning in the watershed, and the drainage area. A procedure for estimating the temporal accumulation of debris was developed so that public agencies will know when to monitor and dredge each debris basin in their jurisdiction. The adoption of rational design methods and policy elements relating to debris basins should minimize the risk of failure of the basins. (See also W91-09781) (Author's abstract) W91-09782

MODELING ALLUVIAL-CHANNEL FLOW BY MULTIMODE CHARACTERISTICS METHOD.

Geological Survey, Reston, VA. For primary bibliographic entry see Field 8B.

#### ENTRAINMENT OF BED SEDIMENT INTO SUSPENSION.

Illinois Univ. at Urbana-Champaign. Dept. of Civil ngineering.

M. Garcia, and G. Parker.

M. Garcia, and G. Farker. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 414-435, April 1991. 10 fig, 2 tab, 31 ref. National Science Foundation grant EAR-8517747.

Descriptors: \*Bed load, \*Entrainment, \*Erosion, \*Sediment transport, \*Sediment-water interfaces, \*Suspended sediments, Bed-load discharge, Fric-Model studies, Particle size, Shear stre

The literature abounds with apparently conflicting relations for predicting the reference near-bed con-centration of suspended sediment or the entrainment rate of noncohesive bed sediment into suspension. Most of these relations have been developed for uniform material. Seven such relations were compared against a common set of experi-mental data for which direct measurements of near-bed concentration were available. The rela-tions put forward by Van Rijn and by Smith and McLean were found to perform best. Van Rijn's formulation depends on the excess of shear stress associated with skin friction above the threshold e to the power of 1.5; in the case of Smith and McLean, the dependence is to the power of unity. A new relation for uniform material, having similar predictive capabilities, but implying a shear stress associated with skin friction to the power of 2.5, was developed using the same experimental data. The new relation was generalized to handle sediment mixtures with the aid of field data. The generalization accounts for the 'hiding' effect due to the presence of grains of different sizes. A test against an independent field data set indicated that the empirical fit can provide reasonable estimates of the sediment entrainment coefficient for beds covered with nonuniform material, for sediment in the size range between 0.0625 mm and 0.50 mm. (Author's abstract) W91-09809

# BED SHEAR STRESS AND SCOUR OVER BED-TYPE RIVER INTAKE.

Grampian Regional Council, Aberdeen (Scotland). Dept. of Water Services.

For primary bibliographic entry see Field 8B.

W91-09810

# PREDICTION OF MAXIMUM SCOUR DEPTH AT SUBMARINE PIPELINES. Nanyang Technological Inst., Singapore. School

of Civil and Structural Engineering. For primary bibliographic entry see Field 8B. W91-09811

COMMUNITY STRUCTURE OF CORAL REFES WITHIN THE VICINITY OF MOTOBU AND SESOKO, OKINAWA, AND THE EFFECTS OF HUMAN AND NATURAL INFLU-

National Univ. of Singapore. Dept. of Zoology. For primary bibliographic entry see Field 4C. W91-09952

# DISPERSIVE EROSION AND ENTISOL-PAN-SPOT GENESIS IN SODIUM-AFFECTED SPOT GENESIS LANDSCAPES.

North Dakota State Univ., Fargo. Dept. of Soil

D. G. Hopkins, M. D. Sweeny, and J. L. Richardson.

Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 171-177, January/February 1991. 5 fig, 3 tab, 35 ref.

Descriptors: \*Erosion, \*Great Plains, \*Panspots, \*Revegetation, \*Sodium, \*Soil chemistry, \*Soil erosion, \*Soil genesis, \*Soil physics, \*Soil water, Bicarbonates, Calcium, Chlorides, Clays, Conductivity, Leaching, Magnesium, North Dakota, Salinity, Sulfates.

In Natriboroll complexes, commonly barren, eroded Entisol or remnant Natriboroll areas occur that are devoid of vegetation. The genesis, stratigraphy, and characteristics of panspots were investi-gated using a detailed grid sampling of 121 pedons in a 20 by 20 m area of panspots (Entisol), revege-tated panspots (Entisol), and Glossic and Leptic Natriborolls. Topographic and soil morphological parameters were compared with electrical conductivity, soluble Ca, Mg, HCO3, Cl, SO4, exchangeable H, sodium adsorption ratio, particle size, and water-dispersible clay. Field evidence clearly showed dispersion-induced erosion resulting from a documented rainstorm. Water-dispersible clay a documentor anisorm, water-dispersione casy supported these observations. Morphologic indica-tors of leaching intensity and results from a salinity survey showed soil properties consistently related to surface vegetation density. In barren panspots, no development was evident but, in revegetated panspots, a leaching regime was evident and modest structural could be seen. Chemical and morphological data suggested two water-movement regimes in panspot development. A diagram-matic model illustrates the role of throughflow and discharge of saline-sodic water and mechanical/ dispersive erosion in panspot genesis. Revegetated panspot zones result from a renewal of soil development that slowly reverses the effects of dispersive erosion. Lateral water flow in anisotropic, sodic parent materials is a major factor in the development of panspots. (Author's abstract) W91-09967

# NET EROSION ON A SAGEBRUSH STEPPE AS DETERMINED BY CESIUM-137 DISTRIBU-

Wyoming Univ., Laramie. Dept. of Botany D. Coppinger, W. A. Reiners, I. C. Burke, and R. K. Olson.

Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 254-258, January/February 1991. 2 fig, 1 tab, 36 ref.

Descriptors: \*Cesium radioisotopes, \*Deposition, \*Erosion, \*Radioactive tracers, \*Soil erosion, \*Steppes, \*Vegetation effects, Sagebrush, Scale factors, Semiarid climates, Statistical analysis, Wind erosion, Wyoming.

Soil erosion plays a major role in structuring land-scapes of semi-arid regions. Patterns and transport mechanisms of soil erosion and deposition in a native sagebrush steppe landscape in south central Wyoming were examined using cesium-137. Six landscape units were identified using a cluster anal-ysis based on four landscape variables. Cesium-137 values varied little among landscape units, suggest-ing that intermediate-scale (approximately 100 m) fluvial and eolian soil transport is unimportant in this system during the time since bomb-test cesiumthis system during the time since bomo-test cestum-137 deposition occurred. In contrast, analysis of variance showed that, on windswept landscape positions, cesium-137 was significantly higher under shrubs than between them. These differences

suggest that wind-driven redistribution has oc-curred at a small scale (0.5-10 m). Even though cesium-137 data indicate that intermediate-scale transport is not occurring, analysis of the soil fine fraction across the landscape shows net transport of fines downslope, suggesting that, in this sage-brush ecosystem, soil redistribution by fluvial erosion occurs too slowly to be determined by cesium-137. (Author's abstract) W91-09973

# FLUVIAL DESIGN OF RIVER BANK PROTEC-TION FOR SANTA CRUZ RIVER.

San Diego State Univ., CA. Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 7C.
W91-10028

# NUMERICAL MODELING OF ARID REGION FLOOD HAZARDS.

Simons, Li and Associates, Inc., Newport Beach, CA.

For primary bibliographic entry see Field 2E. W91-10042

# ROLE OF QUANTITATIVE GEOMORPHO-LOGY IN THE HYDROLOGICAL RESPONSE OF RIVER NETWORKS.

Water Resources Research and Documentation Centre, Villa La Colombella, 06080 Colombella, Perugia, Italy

For primary bibliographic entry see Field 2E. W91-10113

#### RIVER MECHANICS: A UNIVERSAL AP-PROACH.

Rand Afrikaans Univ., Johannesburg (South Africa). Systems Lab. For primary bibliographic entry see Field 2E. W91-10119

# MATERIAL TRANSPORT BY THE WORLD'S RIVERS: EVOLVING PERSPECTIVES,

Exeter Univ. (England). Dept. of Geography. D. E. Walling, and B. W. Webb. IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 313-329, 6 fig, 5 tab, 62 ref.

Descriptors: \*River sediments, \*Sediment transport, \*Sediment yield, \*Sediment-carrying capacity, \*Suspended sediments, Africa, Asia, Australia, Bed load, Europe, Particulate matter, Sediment load, Solute transport.

Measurements of material transport by rivers were first undertaken more than 150 years ago and the significance of the resultant data has become increasingly apparent. Global minima for specific suspended sediment yield in areas evidencing significant annual runoff lie well below 2 t/sq-km/yr. Increased data availability can do little to modify popular views of minimum levels suspended sedi-ment yield, but it has significantly changed the perception of the upper bound in recent years, from 2,000 to >50,000 t/sq-km/yr, and considerable progress has been made towards producing a able progress has been made towards producing a consistent and generally acceptable map of the global pattern of sediment yields. The assumption that bed load represents only a small proportion of the total load has caused inaccuracy in measurements of this component of particulate transport. However, new data have suggested that bed load expressed as a proportion of the suspended load averages 8 and 23% in plains and mountain rivers respectively. A number of generalizations are not respectively. A number of generalizations are possible regarding dissolved loads of the world's stole regarding dissolved loads of the world's rivers: a range of values likely to be encountered is from <1.0 t/sq-km/yr to >750 t/sq-km/yr; a generalized global map of solute yields has been developed; the high load values mapped for many Asian rivers are a response to their high runoff; the low dissolved loads characteristic of Africa and Australia reflect the existence of ancient basement rocks with a low susceptibility to chemical weathering. Data availability has improved considerably in

# Chemical Processes—Group 2K

recent years for total annual transport of material by rivers from the land surface of the globe to the oceans. It is estimated that the total suspended sediment transport to the oceans is 13.5 billion t/ sediment transport to the oceans is 13.5 billion ty, the estimate of total dissolved load transport to the oceans is 3.7 billion t/yr, and the total material transport from the land to the oceans is 19-20 billion t/yr. In terms of absolute magnitude of the suspended sediment loads for individual continents, Asia provides the highest load, and Europe the lowest. In the future, these estimates should be further refined using additional data. (See also W91-10103) (Fish-PTT) W91-10133

CLAY MINERAL DISTRIBUTIONS AND SOURCE DISCRIMINATION OF UPPER QUA-SUJUKUE DISURIMINATION OF UPPER QUATERNARY SEDIMENTS, LOWER CHESA-PEAKE BAY, VIRGINIA.
Delaware Univ., Lewes. Coll. of Marine Studies. For primary bibliographic entry see Field 2L. W91-10173

EVALUATION AND APPLICATION OF DIAL-YSIS POREWATER SAMPLERS FOR MICRO-BIOLOGICAL STUDIES OF SEDIMENT-WATER INTERFACES. Zurich Univ. (Switzerland). Inst. of Plant Biology. For primary bibliographic entry see Field 7B. W91-10215

DIATOM, POLLEN, AND SEDIMENT MICROSTRATIGRAPHIC INVESTIGATIONS OF ANTHROPOGENIC EFFECTS ON LAKE HOELLER (UPPER AUSTRIA) (DIATOMEEN, POLLEN, AND SEDIMENTMIKROSTRATIGRAPHISCHE UNTERSUCHUNGEN ZUR ANTHROPOGENEN BEEINFLUSSUNG DES HOELLER SEES (OBEROSTERREICH)). Akademie der Wissenschaften der DDR, Berlin. Ern primary hibliographie entry see Filold 2H For primary bibliographic entry see Field 2H. W91-10216

PIGMENT PRESERVATION IN LAKE SEDI-MENTS: A COMPARISON OF SEDIMENTARY ENVIRONMENTS IN TROUT LAKE, WISCON-

Wisconsin Univ.-Madison. Water Chemistry Program. For primary bibliographic entry see Field 2H. W91-10224

REMOTE SENSING OF LANDSCAPE PROC-

Commonwealth Scientific and Industrial Research Organization, Alice Springs (Australia). Div. of Wildlife and Rangelands Research. For primary bibliographic entry see Field 7B. W91-10384

# 2K. Chemical Processes

LONG-TERM IONIC INCREASES FROM A CENTRAL APPALACHIAN FORESTED WA-

Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab. For primary bibliographic entry see Field 5B. W91-09353

RADIOELEMENT DISTRIBUTION IN RIVER, BEACH, AND OFFSHORE AREAS AND THEIR SIGNIFICANCE TO CHAVARA PLACER DE-POSIT, SOUTHERN KERALA COAST OF

Centre for Earth Science Studies, Trivandrum (India).

For primary bibliographic entry see Field 2J. W91-09379

SHPOL'SKII FLUORIMETRY AS AN INDE-PENDENT IDENTIFICATION METHOD TO UPGRADE ROUTINE HPLC ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS.

Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.

For primary bibliographic entry see Field 5A. W91-09422

APPLICATION OF GAS CHROMATOGRA-PHIC TECHNIQUES FOR CHARACTERIZING VAPOR SORPTION ON SOILS: A REVIEW. Florida Univ., Gainesville. Dept. of Soil Science. For primary bibliographic entry see Field 5B. W91-09428

GROUNDWATER GEOCHEMISTRY AND RADIONUCLIDE ACTIVITY IN THE CAMBRIAN-ORDOVICIAN AQUIFER OF DODGE AND FOND DU LAC COUNTIES, WISCONSIN. Wisconsin Univ.-Madison. Dept. of Geology and

Geophysics. For primary bibliographic entry see Field 2F. W91-09470

PHYSICAL AND CHEMICAL DATA FOR GROUND WATER IN THE MICHIGAN BASIN,

Geological Survey, Lansing, MI. Water Resources

For primary bibliographic entry see Field 2F. W91-09484

SURFACE-CHEMICAL FACTORS AFFECTING TRANSPORT OF BIOCOLLOIDS IN SUBSUR-FACE POROUS MEDIA.

Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.

water Resources.
R. C. Bales, and C. P. Gerba.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-107326/
AS. Price codes: A07 in paper copy, A07 in microfiche. Final Report, October 1990. 138p, 56 fig, 14
tab, 67 ref, 3 append. USGS Contract no. 14-08-001-G1501.

Descriptors: \*Adsorption, \*Assay, \*Bacteria, \*Colloid transport, \*Desorption, \*Groundwater, \*Porous media, Cape Cod, Column experiment, Hydrogen ion concentration, Interaction potentials, Isotherms, London-van der Waals interactions, Massachusetts, Partition coefficient, Silica beads, Temperature effects.

Adsorption and transport of bacteriophage and Poliovirus were studied in laboratory experiments and in a month-long field injection. In the column experiments, adsorption of the bacteriophage PRD-1 and MS-2 to silica beads at pH 5.0-5.5 was reversible, however release of attached phage was slow and breakthrough curves exhibited significant tailing. Modeling the experimental curves using a one-dimensional advection-dispersion equation with pseudo-first-order attachment and release gave rate coefficients on the order of 0.0001 sl for adsorption and 0.000001 to 0.0001 sl for desorption. Corresponding time scales for bacteriophage removal were hours for adsorption and days for desorption. The sticking efficiency (alpha) for phage attachment was near 1.0. Phage release was enhanced by raising pH and introducing surface-active chemical species. In a series of batch experi-ments MS-2 adsorbed strongly to a hydrophobic surface, octadecyltrichlorosilane-bonded silica, at surface, octadecyltrichlorosilane-bonded silica, at pH 5 was linear, but was 40 (with Ca) to 400 (without Ca) times less than adsorption to the bonded surface. Neither MS-2 nor PRD-1 adsorbed to unbonded silica at pH 7. The slow adsorption, strong pH dependence and reversibility aspects of the laboratory experiments were apparent in the field results. (USGS)

RESULTS OF TEST DRILLING IN HOWELL TOWNSHIP, MONMOUTH COUNTY, NEW

Geological Survey, Trenton, NJ. Water Resources For primary bibliographic entry see Field 2F.

W91-09528

BASE OF MODERATELY SALINE GROUND WATER IN SAN JUAN COUNTY, UTAH. Geological Survey, Salt Lake City, UT. Water

Resources Div. For primary bibliographic entry see Field 2F. W91-09538

SHALLOW GROUND WATER IN THE WHIT-NEY AREA, SOUTHEASTERN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA-PART I. DESCRIPTION OF CHEMICAL QUALITY,

Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-09542

TREND ANALYSIS OF SELECTED WATER-QUALITY CONSTITUENTS IN THE VERDE RIVER BASIN, CENTRAL ARIZONA. Geological Survey, Tucson, AZ. Water Resources

For primary bibliographic entry see Field 5B. W91-09555

MATHEMATICAL SUBMODELS IN WATER QUALITY SYSTEMS.

For primary bibliographic entry see Field 7C. W91-09611

COAGULATION. Karlsruhe Univ. (Germany, F.R.). Inst. fuer Sied-

lungswasserwirtschaft. For primary bibliographic entry see Field 7C.

PRECIPITATION. Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry.

Dept. of Chemistry.
S. E. Jorgensen, and H. H. Hahn.
IN: Mathematical Submodels in Water Quality
Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 141-149. 2 fig, 1 tab, 6 ref

Descriptors: \*Chemical interactions, \*Chemical precipitation, \*Chemical reactions, \*Model studies, \*Thermodynamics, Boundary conditions, Equilibrium, Estimating, Hydrogen ion concentration, Mathematical models, Solubility.

Precipitation in a strictly chemical sense is the transition of a substance from the dissolved state to the non-dissolved state upon the addition of other dissolved reagents and generally occurs at a fast rate. Thus, in most instances, the rate itself is of no direct concern, and there exist no models to describe the rate aspects of the process. The process depends to a large degree upon the equilibrium situation. Thus, there are mathematical models for precipitation that describe the equilibrium or the end-point of the reaction for specified boundary conditions. However, it must be noted that for most practical applications, such models derived from thermodynamic principles may need to be from thermodynamic principles may need to be modified. In fact, there are situations where a quantitative application of these principles is no longer possible. Parameters contained in the ther-modynamic models include the solubility product and the stoichiometric quotient. Estimates for these parameters which control the solution/precipita-tion process can be found in standard literature. tion process can be found in standard literature. However, the possibilities of determining particular site and project specific parameters are not good compared to other modeling situations. Thermodynamic data—the major part of the necessary information—are difficult to determine in situ and require systematic experimentation. (See also W91-0841) (Con PUTT) 09611) (Korn-PTT) W91-09618

COMPLEX FORMATION.

Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry.
S. E. Jorgensen, and A. Jensen. IN: Mathematical Submodels in Water Quality

# Field 2—WATER CYCLE

# **Group 2K—Chemical Processes**

Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 151-169. 10 fig, 4 tab, 16 ref.

Descriptors: \*Chemical interactions, \*Chemical reactions, \*Metal complexes, \*Model studies, \*Organometals, Aquatic environment, Chelating agents, Chelation, Chemical speciation, Equilibria um. Solubility.

Metal ions are able to form coordination complexes with a number of inorganic and organic ions and molecules. The formation of these complexes is playing a major role in modeling the distribution and the effect of metal ions in aquatic ecosystems. The application of coordination chemistry to environmental problems in aquatic ecosystems is very complex because a great number of ligands are all competing in the formation of complexes with the metal ions. Complex formation is, in most cases, a rapid process compared with the time intervals used in a model describing the distribution and effects of metals. Consequently, the process can be described by equilibrium expressions, and generally it is not necessary to take reaction kinetics into consideration. Stability constants for a number of complex processes of environmental interest can be found in many chemical handbooks. A simplification is often possible in practical modeling, because in many cases it is feasible to exclude many complexing agents and include only a few very stable complexes in the model description. Currently, few models consider formation of complexes, because it is presumed that this process is insignificant for the problem at hand. However, it has been shown that the uptake rate of metals by organisms is often highly influenced by the presence of complexes. More experience is needed to give a better estimation concerning the inclusion or omission of com-plex processes in model development. However, the process should be included wherever it seems appropriate and feasible. (See also W91-09611) (Korn-PTT) W91-09619

HYDROLYSIS AND CHEMICAL REDOX

PROCESSES, Royal Danish School of Pharmacy, Copenhagen.

Royal Datish School of Pharmacy, Copennagen. Dept. of Chemistry. S. E. Jorgensen, and A. Jensen. IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 171-193. 13 fig, 6 tab, 8 ref.

Descriptors: \*Chemical interactions, \*Chemical reactions, \*Hydrolysis, \*Model studies, \*Oxidation-reduction potential, Equilibrium, Estimating, Hydrogen ion concentration, Kinetics, Oxidation, Thermodynamics.

The term hydrolysis is applied to processes which can proceed with water, hydrogen ions and hydroxyl ions. Redox processes include those situations where transfer of electrons takes place. While the chemistry of these two processes is different, their environmental consequences are somewhat similar. Many inorganic processes proceed relatively fast compared with the time intervals normally used in environmental models. This implies that equilibrium diagrams can be applied, if the pH and pe are known. However, for some processes, kinetic data may also be needed in the develop-ment of a model. Although both equilibrium and kinetic data for many environmental hydrolysis and redox processes are available in the literature, knowledge of these processes is still rather limited. It is hoped that as the number of toxic substance models rapidly increases, more and more parameters will be defined. In addition, more information eters will be defined. In addition, more information is likely to be published about processes involving toxic substances in the environment in general, since the ecotoxicological consequences of toxic substances are of increasing concern. (See also W91-09611) (Korn-PTT)

PHOTOCHEMICAL REACTIONS.

Old Dominion Univ., Norfolk, VA. Inst. of Oceanography. G. T. F. Wong.

IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Model-ling, 14. Elsevier Science Publishing Co., New York. 1989. p 195-216. 1 fig. 98 ref.

Descriptors: \*Chemical interactions, \*Chemical reactions, \*Geochemistry, \*Model studies, \*Photochemistry, \*Water chemistry, Estimating, Light penetration, Natural waters, Photolysis, Solar radiation, Wavelengths.

Photochemical reactions may have a significant impact on the geochemistry of natural waters. However, at the present time, the overall picture of this field of study is one of immense complexity and lack of information, partially as a result of the state of affairs in aquatic geochemistry in general. Several levels of modeling efforts may be identi-fied. These levels present an increasing degree of complexity, an increasing resemblance to reality and an increasing usefulness in estimating the effects of photochemical reactions in the geochemistry of natural water. In the first level, which includes most of the studies done to date, the models attempt to describe the rate of a given light-induced reaction in a defined medium under a ed light-regime in the laboratory. In the next level, the model may describe photochemical reactions in various media and light-regimes as found in the natural environments. More complex and more usefule would be model that can integrate the total effects of photochemical reactions in the entire water column of different bodies of natural water ranging from highly colored to relatively clear ranging from inginy colored to relatively clear water, eutrophic to oligotrophic water, fresh water to brine, and waters with high to low particulate loads and high to low concentrations of dissolved organic matter. Finally, the ideal model should include physical, biological and other geochemical processes that may affect the chemical composition of natural waters. Thus, advances in modeling photochemical reactions in natural waters will be closely linked to a better appreciation of the geo-chemistry, physics and biology of the aquatic envi-ronment as a whole. (See also W91-09611) (Korn-PTT) W91-09621

MICROBIAL DECOMPOSITION. Centre d'Enseignement et de Recherche pour la Gestion des Ressources Naturelles et l'Environnement, Paris (France). For primary bibliographic entry see Field 7C. W91-09622

NITRIFICATION.

Tokyo Univ. (Japan). Dept. of Urban Engineering. S. Ohgaki, and C. Wantawin.

IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 247-276. 8 fig, 4 tab, 78 ref.

Descriptors: \*Bacterial growth, \*Growth kinetics, \*Model studies, \*Nitrification, \*Nitrogen fixing bacteria, \*Nutrient removal, Aquatic environment, Detention time, Flow characteristics, Microbiolo-gical studies, Streams, Wastewater outfall.

Natural water bodies are quite complex due to their large number of interlinked physical, chemi-cal, and biological processes. A model applicable to the characteristics of one type may be meaning-less for others. However, basic knowledge of nitrification and a clear understanding of the correla-tion between the characteristics of water flow and the growth of nitrifying bacteria will help in developing and applying an effective model for any natural water body. The most substantial assumption in modeling of the nitrification process is in the growth model of the nitrifying microorganisms. Because of the slow growth rate of nitrifying nicroorganisms. ing bacteria, it might be expected that nitrification would be significant only in water bodies with a long detention time. However, nitrification can also occur immediately below a wastewater outfall (by microorganisms attached to the stream bed). The initial concentration of nitrifying bacteria, well as specific growth rates, is important for growth kinetics; however, where there is an insufficiently long detention time for the growth of

nitrifying bacteria, nitrification may still occur if nitrifying bacteria continuously enter the area. nitrilying bacteria continuously enter the area. Therefore, it is insufficient to apply a growth kinetics submodel based only on environmental characteristics, to a particular length of stream without considering the resupply of nitrifying bacteria from upstream. Thus, interrelations between different aquatic habitats should be taken into account when developing nitrification submodels. (See also W91-09611) (Korn-PTT) W91-09623

GROUNDWATER IN THE NATION'S CAPITAL: BEYOND POTABILITY.

District of Columbia Univ., Washington. Dept. of Environmental Science. For primary bibliographic entry see Field 2F. W91-09629

CHEMICAL INTERACTIONS BETWEEN SUR-FACE WATER AND GROUND WATER IN THE ZEKIAH SWAMP RUN STREAM VALLEY.

Environmental Resources Management, Inc., Annapolis, MD. For primary bibliographic entry see Field 2F. W91-09631

NITROGEN TRANSPORT IN GROUND WATER IN TWO GEOLOGIC SETTINGS, PA-TUXENT RIVER BASIN, MARYLAND. Geological Survey, Towson, MD. Water Re-

For primary bibliographic entry see Field 2F. W91-09635

SOLUTE BUDGET FOR AN ARID-ZONE GROUNDWATER SYSTEM, LAKE AMADEUS, CENTRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geo-

physics, Canberra (Australia). G. Jacobson, J. Jankowski, and X. Y. Chen. Australian Journal of Earth Sciences AJESE7, Vol. 38, No. 1, p 1-14, February 1991. 10 fig, 4 tab,

Descriptors: \*Arid-zone hydrology, \*Australia, \*Geochemistry, \*Groundwater chemistry, \*Groundwater movement, \*Playas, \*Saline groundwater, \*Solute transport, \*Surface-groundwater relations, Brines, Groundwater recharge, Mineralization, Saline lakes.

Lake Amadeus, a large playa in central Australia, is the locus of groundwater discharge from a re-gional groundwater flow system extending over a catchment of 66,000 sq km. Most of the ground-water flow occurs in shallow aquifers in Cenozoic sediments, but some flow takes place in deeper aquifers in fractured Proterozoic and Paleozoic rocks. The regional groundwaters evolve from fresh and brackish waters of the HCO3-Cl and Cl-HCO3-SO4 type to hypersaline playa brines of the Cl-Na type. The brines are saturated with respect to calcite, dolomite, gypsum, and glauberite, and are close to saturation with respect to halite. The groundwaters evolve to brines by concurrent processes of dissolution of aquifer matrix, evaporative concentration and mineral precipitation. Ground-water inflow is estimated as 17% of the total water inflow to the playa, the remainder being rainwater. However, nearly 99% of the salt in the brine pool is derived from groundwater. A solute budget for shallow groundwaters calculated on the basis of chloride concentration factors shows that the playa chioride concentration factors shows that the piaya brines are nearly 300 times more concentrated than the recharge groundwaters. Hydrochemical proc-esses in the flow system lead to the virtually com-plete loss of HCO3, Ca, and SiO2, which are taken up in mineral precipitation. Other ions remain in solution, but there are net losses of Mg, SO4, and K relative to chloride, which is conserved. (Author's abstract) W91-09688

PATTERN OF GYPSUM TRANSPORT IN THE EBRO RIVER NETWORK. Exeter Univ. (England). Dept. of Geography.

For primary bibliographic entry see Field 2E. W91-09691

DISSOLVED COMMON GASES IN GROUND-WATERS OF THE APPALACHIAN REGION. Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Science Teaching. For primary bibliographic entry see Field 2F. W91-09709

ACID NEUTRALIZATION CAPACITY VARIATIONS FOR THE HAFREN FOREST STREAM, MID-WALES: INFERENCES FOR HYDROLOGICAL PROCESSES. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2E. W91-09713

HYDROCHEMICAL CHARACTERIZATION OF THE WATER DYNAMICS OF A KARSTIC SYSTEM. Lvon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines. For primary bibliographic entry see Field 2F.

USE OF ISOTOPE FRACTIONATION OF SUL FATE-SULFUR AND SULFATE-OXYGEN TO SESS BACTERIAL DESULFURICATION IN A SANDY AQUIFER.

A SANDY AQUIFER.

Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).

For primary bibliographic entry see Field 2F.

W91-09717

CHEMICAL AND ISOTOPIC EVIDENCE FOR HYDROGEOCHEMICAL PROCESSES OCCURRING IN THE LINCOLNSHIRE LIME-

Birmingham Univ. (England). School of Earth Sci-

For primary bibliographic entry see Field 2F. W91-09724

RUNOFF CHEMISTRY AS AN INDICATOR OF RUNOFF SOURCES AND ROUTING IN SEMI-ARID, BADLAND DRAINAGE BASINS, Alberta Univ., Edmonton. Dept. of Geography. For primary bibliographic entry see Field 2A. W91-09729

GASEOUS DIFFUSION OF CO2 IN THE UN-SATURATED ZONE.
Technical Univ. of Denmark, Lyngby. Fysik-

Kemisk Inst.

S. Laursen. Journal of Hydrology JHYDA7, Vol. 122, p 61-69, January 1991. 3 fig, 6 ref. Danish Technical Re-search Council J.nr. 5.26.09.12.

Descriptors: \*Aeration zone, \*Carbon dioxide, \*Diffusion, \*Gases, \*Model studies, Boundary conditions, Mathematical studies, Root zone, Water

The extent to which simple diffusion may account for transport of CO2 in the unsaturated zone is investigated. This is done by generalizing the War-burg case solution of the diffusion equation to a case with two boundaries, the second accounting for the water table. It is thus assumed that CO2 is produced exclusively in or above the root zone. The diffusion equation is solved with a periodic the diffusion expectation is a periodic to but otherwise arbitrary boundary condition below the root zone and a condition of reflection at the water table. The model is in good agreement with measurements by Reardon and suggests that diffusions to the condition of the condition sion is an important process in such cases. It is suggested that the introduction of more complicatsuggested that the introduction of more complication and edition of the attempted, as this would introduce more parameters. The number of parameters should, however, be kept at an absolute minimum because many parameters mean that a vast amount of measurements are required in order to be fitted, and because it usually does not improve the understanding of such complicated processes. (Agostine-PTT)

W91-09736

SPECTRAL RESPONSE OF SUSPENDED SEDIMENTS IN WATER UNDER CONTROLLED CONDITIONS. Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.

For primary bibliographic entry see Field 7B. W91-09748

FACTORS INFLUENCING MERCURY CON-CENTRATION IN WALLEYES IN NORTHERN WISCONSIN LAKES.

National Fisheries Contaminant Research Center, La Crosse, WI. Field Research Station. For primary bibliographic entry see Field 5B. W91-09766

RESULTS OF TEST DRILLING AND HYDRO-LOGIC MONITORING IN THE INDIAN BATHTUB AREA, OWYHEE COUNTY, SOUTHWESTERN IDAHO, JANUARY 1989 THROUGH SEPTEMBER 1990. Geological Survey, Boise, ID. Water Resources

Div.

For primary bibliographic entry see Field 7C. W91-09830

GEOCHEMISTRY OF SOILS OF SPITSBER-

Moscow State-Lenin Pedagogical Institute. For primary bibliographic entry see Field 2G. W91-09947

SOIL PH AND ALUMINIUM AND THEIR SPA-TIAL VARIATION IN WESTERN AUSTRA-LIAN ACIDIC SOILS,

Western Australia Dept. of Agriculture, Northam. Avon Districts Agriculture Centre. P. J. Dolling, W. M. Porter, and A. D. Robson. Australian Journal of Experimental Agriculture AAAHAN, Vol. 30, No. 5, p 637-643, 1990. 6 fig. 1 tab, 21 ref.

Descriptors: \*Acidic soils, \*Acidification, \*Agricultural practices, \*Aluminum, \*Australia, \*Hydrogen ion concentration, \*Soil chemistry, Agriculture, Barley, Soil horizons, Spatial variation,

Thirty-eight sites on acidic soils (pH<5.5, 1:5 in water) in the medium rainfall region of Western Australia were sampled to examine spatial variation in soil pH and 0.01 mol/L CaCl2-extractable aluminum. The relationships between (i) the A1 and A2 horizon soil pH, (ii) the A1 and A2 horizon for tractable aluminum. extractable aluminum, (iii) surface and subsurface soil pH and (iv) surface soil and subsurface soilextractable Al were also examined. Soil at each site generally had a light-textured layer overlying a site generally had a light-textured layer overlying a clay layer at varying depths (30-70 cm) and, using the Northcote system, was classified as either Dy 5.21 or Dy 5.41. Over 80% of the sites had surface soil pH values 4.8 or lower and extractable aluminum concentrations 2 micrograms/g or higher. There was a very poor correlation between the A1 horizon soil aluminum extracted in 0.01 mol/L CaCl2 and the pH measured in 0.01 mol/L caCl2 and t over 1 ha sites. The relationship was slightly improved in the A2 horizon. The coefficients of variation varied from 1.2 to 5.1% for soil pH, and from 10 to 50% for CaCl2-extractable aluminum. At many of the sites, low pH values and high aluminum concentrations extended down to 35-45 cm. At the B horizon the pH values generally increased and the aluminum concentrations decreased. The surface soil pH and extractable aluminum were not good indicators of the subsurface soil pH and extractable aluminum. (Author's abstract) W91-09949

SPATIAL SCALE DEPENDENCE OF IN SITU SOLUTE TRANSPORT.

Guelph Univ. (Ontario). Dept. of Land Resource For primary bibliographic entry see Field 2G.

W91-09960

HUMIC AND FULVIC ACID ADSORPTION BY SILICON AND ALUMINUM OXIDE SURFACES ON CLAY MINERALS. National Chemical Lab. for Industry, Yatabe

(Japan)

(Japan).
C. P. Schulthess, and C. P. Huang.
Soil Science Society of America Journal SSSJD4,
Vol. 55, No. 1, p 34-42, January/February 1991. 8
fig. 24 ref. NSF Grant no. 1 CEE 8104728; U.S.
Dept. of Energy, Contract no. DE-AC05840R21400.

Descriptors: \*Adsorption, \*Aluminum, \*Clay minerals, \*Fulvic acids, \*Humic acids, \*Oxides, \*Silicon, \*Soil chemistry, Clay soils, Humic substances, Hydrogen ion concentration, Kaolinite, Montmorillonite, Mordenite, Organometals.

Natural (untreated) clays are most probably amor-phous on their outermost surface layers due to the continuous on their outermost surface layers due to the continuous and natural process of partial dissolution and reprecipitation of the clay components at the solid-aqueous interface. The pH-dependent adsorption on Al and Si oxides, mordenite, kaolinite, and montmorillonite of a humic acid (HA) and a foliation of (RA) were about the continuous conti fulvic acid (FA) was described as occurring on Al and Si sites. The surfaces of the clay minerals were and Si sites. In e surfaces of the clay minerals were modeled as mixtures of amorphous Al and Si oxides. The results showed a strong adsorption of the organics by the Al sites on the Al oxide and kaolinite, and a weak adsorption of organics by the Si sites on the Si oxide, mordenite, and montmorillonite. At low pH values, the Si sites on the Si ionite. At low pri values, the stistes on the si oxide, mordenite, and montmorillonite adsorbed FA; these latter observations strongly suggest that the adsorption of FA by the interplanar spaces of expanding clays is driven by forces that can be studied using amorphous Si oxide as the adsorbent. Multivalent eations will form organometallic complexes that significantly increase adsorption, par-ticularly on Si sites; exceptions were found with some FA-metal complexes, which were attributed to the degree of complexation. The implication of these observations is that, in natural systems, the adsorption of aqueous compounds is highly de-pendent on the type of (amorphous) surface present at the outermost layer of the solid phase in contact with the liquid phase. (Author's abstract)

CLAY MINERAL TYPE AND ORGANIC COM-POUND SORPTION BY HEXADECYLTRI-METHYLAMMONIUM-EXCHANGED CLAYS.

Michigan State Univ., East Lansing. Dept. of Crop and Soil Science For primary bibliographic entry see Field 5B. W91-09963

COMPARISONS OF HUMIC SUBSTANCES EXTRACTED FROM CONTIGUOUS ALFISOLS AND MOLLISOLS OF SOUTHWESTERN OHIO

Savannah River Ecology Lab., Aiken, SC. For primary bibliographic entry see Field 2G. W91-09964

RELATIVE IMPORTANCE OF SEASONAL, SHORT-TERM PH DISTURBANCES DURING DISCHARGE VARIATION ON A STREAM DISCHARGE ECOSYSTEM.

Ontario Ministry of the Environment, Dorchester. Dorset Research Center. For primary bibliographic entry see Field 5C. W91-09997

MEASUREMENT OF PHOSPHORUS UPTAKE LENGTH IN STREAMS: COMPARISON OF RADIOTRACER AND STABLE PO4 RE-

LEASES. Oak Ridge National Lab., TN. Environmental Sciences Div

P. J. Mulholland, A. D. Steinman, and J. W. Elwood.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2351-2357,

# Field 2—WATER CYCLE

# **Group 2K—Chemical Processes**

December 1990. 3 fig, 3 tab, 31 ref. US DOE DE-AC05-84OR 21400.

Descriptors: \*Nutrient concentrations, \*Phosphates, \*Streams, \*Uptake rates, \*Water chemis-try, Bioavailability, Freshwater, Phosphorus, Ra-dioactive tracers, Regression analysis, Stream

Experimental releases of radiotracer and stable PO4 were conducted on the same or consecutive days in a temperate first-order woodland streams to determine if both techniques resulted in similar measures of PO4 uptake length (Sw). For each set of experiments, Sw measured by radiotracer re-leases was substantially shorter than Sw measured by stable PO4 releases. For stable PO4 releases, Sw was shorter for releases resulting in small in-creases in PO4 concentration in water (7 to 12 microg P/L), than for releases resulting in larger increases in PO4 concentration (84 to 163 microg P/L). Although the uptake rate of PO4 increased with PO4 concentration, the increase in uptake rate was not sufficient to offset increases in down-stream flux of PO4 with stable PO4 additions, thus resulting in longer Sw. A plot of PO4 uptake rate against PO4 concentration suggested two uptake echanisms. Biologically controlled uptake at low PO4 concentrations appeared to become saturated at concentrations above approximately 5 microg P/L, and physical/chemical adsorption at high PO4 concentrations continued to increase with in-creasing concentration. Results indicate that stable PO4 releases will overestimate ambient Sw unless PO4 increases are sufficiently small that they do not approach saturation of the biological comm ty. (Author's abstract) W91-10000

CHLORIDE AND SULFATE SALINITY EFFECTS ON SELENIUM ACCUMULATION BY TALL FESCUE.

California Univ., Davis. Dept. of Environmental

Horticulture.
For primary bibliographic entry see Field 5B.
W91-10170

TRACE ELEMENT ANALYSIS OF WATER USING RADIOISOTOPE INDUCED X-RAY FLUORESCENCE (CD-109) AND A PRECONTRATION-INTERNAL STANDARD METHOD (MEDIDA DE ELEMENTOS META-LICOS A NIVEL DE TRAZAS EN AGUAS POR MEDIO DE FLUORESCENCIA DE RAYOS X CON RADIOISOTOPOS (CD-109) UTILI-ZANDO UN METODO DE PRECONCENTRA-CION Y ESTANDARIZACION INTERNA). Universidad Nacional Pedro Henriquez Urena, Santo Domingo (Dominican Republic). Dept. de

For primary bibliographic entry see Field 5A. W91-10249

ENZYMATIC ACTIVITY OF THE SOIL UNDER A FLOODPLAIN FOREST AND ITS CONNECTION WITH THE BIOLOGICAL RE-CYCLING OF NUTRIENTS

For primary bibliographic entry see Field 2G. W91-10307

CYCLING OF MINERAL NUTRIENTS. Brno Univ. (Czechoslovakia).

E. Klimo. IN: Floodplain Forest Ecosystem. Part I: Before Water Management Measures. Developments in Agricultural and Managed-Forest Ecology, 15A. Elsevier Science Publishing Co., New York. 1985. p 425-459, 4 fig, 32 tab, 20 ref.

Descriptors: \*Cycling nutrients, \*Czechoslovakia, \*Flood plains, \*Floodplain forests, \*Forest ecosystems, \*Riparian vegetation, \*Soil chemistry, Carbon, Flooding, Humus, Magnesium, Nitrogen, Phosphorus, Potassium, Precipitation, Soil profiles.

The concentration and reserves of elements were estimated in all components of a floodplain ecosystem in Czechoslovakia. This ecosystem shows high reserves of elements, partly in soil and partly in the tree, shrub and herb layer. Although the regular input of nutrients into this ecosystem resulting from annual floods has been interrupted due to the improvement of the water regimes, the input of elements from neighboring agroecosystems plays an important role in the nutrient balance of this floodplain forest. The nutrient values may also be affected by intensive turbulence above the forest canopy, which transports soil particles into the precipitation collectors. Surface humus represented an important dynamic component of the flood-plain forest ecosystem under study. This humus was of the mull type, and it showed characteristic changes both in the total mass and concentration of elements within the year. The migration of elements within the soil profile was studied using the method of analysis of lysimetric water. Among the elements released within the year from surface humus, carbon showed the highest value (156 kg/s) humus, caroon showed the mignest value (130 kg/ha). Calcium showed a relatively high value of migration in lysimetric water (125 kg/ha/y). Potassium and phosphorus accumulated in the surface horizon of the soil profile in particular. The annual norizon of the son profile in particular. The annual uptake of elements by the tree, shrub, and herb layer was calculated as 224, 18, 129, 265, and 24 kg/ha of N, P, K, Ca, and Mg, respectively. (See also W91-10298) (White-Reimer-PTT) W91-10308

AQUATIC CHEMICAL KINETICS: REACTION RATES OF PROCESSES IN NATURAL WATERS.

Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. 545p. Edited by Werner Stumm.

Descriptors: \*Adsorption, \*Biotransformation, \*Chemical reactions, \*Environmental chemistry, \*Fate of pollutants, \*Geochemistry, \*Kinetics, \*Organic pollutants, \*Water chemistry, Carbonates, Colloids, Minerals, Model studies, Oxidation, Oxides, Trace metals, Weathering.

This book aims to treat features of chemical kinetics in aqueous solutions and in the context of aquatic systems (oceans, fresh water, atmospheric water, and soil), to strengthen the understanding of reaction mechanisms and of specific reaction rates in natural waters and in water technology, and to stimulate innovative research in aquatic chemical kinetics. Kinetics is introduced as a discipline and basic principles emphasizing the elementary reac-tion as a basic unit of chemical processes are given. The environmental factors that are of importance in controlling the rate of chemical transformations are discussed and chemical catalysis in the areas of cloud chemistry, groundwater chemistry, and water treatment processes are illustrated. Linear between kinetics and equilibria, especially for reac-tions of homologous series of compounds in order to procure kinetic information on reactions that have not been determined in the laboratory. Such information is useful in the chemical transformation of chemical pollutants and in redox processes. The possibility of the rates of biogeochemical reactions being controlled by the rates of metal coordination reactions is discussed. Special attention is paid to the kinetics of surface reactions. The discussion spans the range from ab initio quantum mechanical calculations and frontier-molecular-or-bital theories to extracellular enzymatic reactions and includes the adsorption of organic solutes and redox processes occurring at these surfaces. It is shown that the geochemical cycling of electrons is not only mediated by microorganisms but is of importance at particle-water interfaces, especially at the sediment-water interface due to strong redox gradients and in surface waters due to heterogeneous photoredox processes. This volume also reflects the great progress achieved in recent years in the study of kinetics of the dissolution of oxide and carbonate minerals and the weathering of minerals. The kinetics of colloid chemical processes and the role of surficial transport processes in geochemical and biogeochemical processes are used to demon-strate that the spatial and temporal heterogeneities and chemical versus transport time scales need to be assessed in order to treat the dynamics of real systems. (See W91-10310 thru W91-10327) (Geiger-PTT) KINETICS OF CHEMICAL TRANSFORMA-TIONS IN THE ENVIRONMENT.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. A. T. Stone, and J. J. Morgan.

A. 1. Stone, and J. J. Morgan. IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 1-41. 8 fig. 2 tab, 46 ref.

Descriptors: \*Biotransformation, \*Chemical degradation, \*Chemical reactions, \*Environmental chemistry, \*Fate of pollutants, \*Kinetics, \*Path of pollutants, Adsorption, Chemical interactions, Hydrolysis, Organic pollutants, Temperature, Therwedthermic

Chemical kinetics is an integral part of models of natural systems. The basic unit of chemical kinetics, the elementary reaction is illustrated in the base-catalyzed hydrolysis of carboxylic acid esters. Collections of elementary reactions that represent entire chemical processes are discussed. These include: reactions in series, reactions in parallel, re-versible reactions, combined chemical kinetics and mass transport. More complex models have been formulated and used to investigate the dynamics of real systems. Adsorption and partitioning phenomena are responsible for distributing chemicals among available phases. The flux of chemicals to and from surfaces depends on the magnitude of forces causing molecular movement and on the dimensionality of the system. Molecules in solution are transported by the mean motion of water, the advection process. Molecules also move relative to the water by diffusion, in response to concentra-tion gradients. For ions, electrostatic forces that contribute to movement are also experienced in regions of changing electrical potential. Whenever two phases come in contact with one another, an interfacial region forms within which physical and chemical characteristics of each phase are dis-turbed relative to interior (bulk) regions of each phase. Kinetics of surface chemical reactions are governed by the elementary reactions that consti-tute the reaction mechanism. Sources of kinetic and mechanistic information to predict rates and pathways of transformation include: empirical observations, thermodynamic information, tentative mechanisms, general trends in ligand replacement reactions of metal ion complexes, general reactivity of organic functional groups, and linear free-energy relationships. (See also W91-10309) (Geiger-PTT)

FORMULATION AND CALIBRATION OF EN-VIRONMENTAL REACTION KINETICS; OXI-DATIONS BY AQUEOUS PHOTOOXIDANTS AS AN EXAMPLE.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland). J. Hiogne.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Sci-ence and Technology Series. John Wiley & Son, New York. 1990. p 43-70. 7 fig, 4 tab, 54 ref.

Descriptors: \*Calibrations, \*Chemical reactions, \*Environmental chemistry, \*Fate of pollutants, \*Kinetics, \*Oxidation, \*Path of pollutants, \*Photochemistry, \*Water chemistry, Chemical degradation, Dissolved organic carbon, Dissolved solids, Dry deposition, Organic matter, Photolysis.

Within an environmental compartment physical and chemical transformations of specified chemical compounds such as pollutants, probe compounds or any other chemical species P, are generally controlled both by different environmental factors, such as the activities of environmental ractors, such as the activities of environmental reactants acting on them (driving force), and the compound-specific rate constant kj.P, with which the chemical structures of P respond to such factors. The reaction-rate constant kj.P is a chemical constant characteristic of a compound P with general validity or it can be measured in laboratory experiments designed to isolate the effect of a single environmental factor j. Only a few types of environmental factors can be quantified by direct measurement of

# Chemical Processes—Group 2K

the concentrations of the reactants mediating the reactions (e.g., pH or concentration of a complex-ing compound). Most factors cannot be easily measured in a direct way, and a calibration assay procedure is more effective--the particular environmental factor is calibrated by observing the rate of loss of a probe compound P, which must react scalusively with the considered environmental factor. The rate of primary photolysis for a species P in irradiated water can be described by combining the photolytic factors characteristic of the chemical compound itself and the relevant envi-ronmental factor (i.e., spectral light intensity). In surface waters the photoinduced electronic excita-tion of ground-state (triplet) oxygen molecules to short-lived singlet oxygen is sensitized by dissolved organic material (DOM). Laboratory studies with furfuryl alcohol have shown that the steady-state concentration of singlet oxygen increases propor-tionally to the amount of light absorbed by the DOM. The kinetics of reaction of OH radicals with interfering sinks has been extensively calibrated for waters in which OH was produced from decomposed ozone or UV-photolyzed hydrogen peroxide. From such data it is predicted that the concentration of OH should increase with increase ing concentration of the precursor, relative to the concentration of DOM. The effect of solvated concentration of DOM. The effect of solvated electrons on reactive micropollutants can be estimated by combining this value with second-order reaction-rate constants found in comprehensive tables. The dry deposition of atmospheric photooxidants and other environmental factors can also contribute to the photooxidation of environmental contribute of the photooxidation of environmental contribute to the environmental pollutants. ((See also W91-10309) (Geiger-PTT) W91-10311

CATALYSIS IN AQUATIC ENVIRONMENTS. California Inst. of Tech., Pasadena. Dept. of Environmental Engineering Science.

ronmental Engineering Solution.

M. R. Hoffmann.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 71-111. 4 fig, 72 ref.

Descriptors: \*Catalysis, \*Catalysts, \*Chemical reactions, \*Environmental chemistry, \*Fate of pollutants, \*Kinetics, \*Water chemistry, Acids, Bases, Enzymes, Esters, Hydrolysis, Metal complexes, Metals, Photoactivation

Chemical catalysis plays an important role in a variety of chemical reactions that take place in the natural aquatic environment. Catalysis can be treated rigorously with respect to kinetic formulations and mechanistic descriptions. The predomi-nant form of catalysis encountered in natural waters is specific-acid and specific-base catalysis. In several situations trace metal catalysis and surface catalysis of reactions can play an important role in the transformation of chemical species in the aquatic environment. The autoxidation of S(IV) in clouds is highly sensitive to catalysis by Fe(III) and Mn(II), while the autoxidation of Mn(II) to MN(III)/Mn(IV) and V(IV) to V(V) is sensitive to surface catalysis by metal oxides and oxyhydroxides. However, surface-catalyzed reactions may be limited by diffusion through porous matrices in certain systems. Homogeneous and heterogeneous photocatalysis in aquatic systems ex-posed to light can play significant roles in the transformation of chemical compounds. The exper-imenter should be cognizant of these latter phenomena when performing experiments pertinent to the aquatic environment (i.e. light as a potential reaction variable is often ignored). (See also W91-10309) (Geiger-PTT) W91-10312

PRINCIPLES OF LINEAR FREE-ENERGY AND STRUCTURE-ACTIVITY RELATION-SHIPS AND THEIR APPLICATIONS TO THE FATE OF CHEMICALS IN AQUATIC SYS-TEMS.

Minnesota Univ., Minneapolis. Dept. of Civil and

Mineral Engineering. P. L. Brezonik.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons,

New York. 1990. p 113-143. 6 fig, 8 tab, 60 ref.

Descriptors: \*Bioaccumulation, \*Chemical reactions, 'Energy transfer, 'Fate of pollutants, 'Kinetics, 'Molecular structure, 'Structure-activity relationships, Biodegradation, Correlation analysis, Equilibrium, Organic compounds, Topology, Tox-

Effects of substituents on reaction rates of related Effects of substituents on reaction rates of related organic compounds generally reflect their electron-donating and/or withdrawing and steric properties. These effects can be quantified and used to produce linear free-energy relationships (LFERs) that predict rates of reactions from the equilibrium properties of the reactants and products. However, because of scatter in relationships, LFER predictions of organic transformation rates in natural variety generally are useful only as first approximawaters generally are useful only as first approxima-tions. Simple property-property correlations and property-activity relationships--e.g., bioaccumula-tion vs. the logarithm of the octanol/water partition vs. the logarithm of the octanol/water parti-tion coefficient (log Kow)—are essentially LFERs. Although such relationships are empirical, they work because they express underlying fundamental relationships. Their accuracy is limited, however, by both measurement problems and theoretical constraints, and caution must be observed in extending such equations (for predictive purposes) beyond the compounds on which they are based. aple attribute-reactivity relationships work best when limited to compounds that behave similarly (i.e., induce response by the same mechanism).

Correlations based on fundamental molecular (or atomic) properties (LFERs, predictions based on molecular mechanics) and molecular topology (MC indices) show much promise. In spite of their (MC indices) show much promise. In spite of their empiricism, MC indices are attractive because of their high correlations with many physical, chemical, and biological variables. Their deterministic nature is an advantage relative to variables such as Kow, which can have large measurement uncertainties. (See also W91-10309) (Geiger-PTT) W91-10313

KINETICS OF TRACE METAL COMPLEXA-TION: IMPLICATIONS FOR METAL REAC-TIVITY IN NATURAL WATERS.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-

bendorf (Switzerland).

J. G. Hering, and F. M. M. Morel.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 145-171. 8 fig, 7 tab, 75 ref.

Descriptors: \*Chemical reactions, \*Fate of pollutants, \*Kinetics, \*Metal complexes, \*Path of pollutants, \*Toxicity, \*Trace metals, Aluminum, Chemical speciation, Copper, Molecular structure, Organic compounds, Phytoplankton, Water pollution effects.

An understanding of coordination kinetics between metals and organic ligands allows for rationaliza-tion (and even prediction) of the mechanisms and and even prediction) of the mechanisms and trates of reactions of well-defined ligands even in complicated systems. The rates of complexation reactions in natural waters depend on the initial speciation of both metals and ligands, the type of perturbation, the relative concentrations of react-ing species, the strength of metal-ligand interactions, and the ligand structure (particularly the extent of competitive metal binding). The difficulties in applying the principles of coordination ki-netics derived from the study of well-defined ligands to naturally occurring ligands arise primarily because of our limited knowledge of their structure and the nature of their interactions with metals. Of and the nature of their interactions with metals. Or particular importance is the extent to which competing metals interact with specific binding sites, the heterogeneity of binding sites, and the contribution of electrostatic effects to the apparent affinition. ty of specific binding sites. The observed kinetic behavior of strong complexing agents suggest that coordination kinetics may be slow in natural waters, especially in systems containing mixtures of strong and weak ligands and high concentrations of alkaline earth metals or mixtures of competing transition metals. The importance of coordination kinetics is illustrated in the oxidation of

Fe(II) in the presence of complexing ligands, the equilibration of Co60-EDTA with soil, the constraints on biological metal uptake due to coordination kinetics, and the indirect Al toxicity to phytoplankton by displacement of Cu(II) by Al from complexes with naturally occurring ligands. (See complexes with naturally occurring ligands. (See also W91-10309) (Geiger-PTT) W91-10314

FRONTIER-MOLECULAR-ORBITAL THEORY APPROACH IN GEOCHEMICAL PROCESSES, Delaware Univ., Lewes. Coll. of Marine Studies. G. W. Luther.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 173-198. 10 fig. 2 tab, 39 ref, append. NSF Grants OCE-8696121 and OCE-8916804.

Descriptors: \*Environmental chemistry, \*Fate of pollutants, \*Geochemistry, \*Molecular structure, \*Oxidation, \*Quantum mechanics, \*Structure-activity relationships, Catalysis, Hydrogen sulfide, Iron, Manganese, Minerals, Oxygen, Pyrite, Trace

Several oxidation-reduction reactions are described in the context of frontier molecular-orbital theory. in the context of trontier molecular-orbital theory. The oxidation of hydrogen sulfide and FeS2 by triplet molecular oxygen (O2) can be described more as an outer-sphere rather than an inner-sphere process. The difference in reactivity of Fe(III) and Mn(IV) minerals with H2S is due to the difference in the symmetry of the frontier molecular orbitals for Fe(III) and Mn(IV). Where SE(III) is a high-gain labile press fection that as Fe(III) is a high-spin, labile metal cation that can undergo ligand exchange under appropriate conditions, Mn(IV) is an inert metal cation that conditions, Mn(IV) is an inert metal cation that does not undergo ligand exchange even under acidic conditions. Halogens and hydrogen peroxide will readily react with pyrite which can be considered a polysulfide ion bound to an Fe(II) ion. Fe(II) oxidation by O2 can occur via outersphere processes, whereas Mn(II) oxidation by O2 must occur via inner-sphere processes. Use of frontier molecular-orbital theory in the above reactions eliminates the need for detailed quantum-mechanieliminates the need for detailed quantum-mechan cal computations and allows the prediction of the relative reactivity of oxidants and reductants through a knowledge of electron-occupied and electron-accepting orbitals. The frontier molecuelectron-accepting orbitals. The frontier molecular-orbital theory also helps determine the pH dependence of reactions, the importance of metals in catalysis, whether inner-or outer-sphere mechanisms are most favored, which intermediates are most likely, the relative activation energy of the transition state, and which end products are most likely to be formed. (See also W91-10309) (Geiger-PTT) PTT) W91-10315

CHEMICAL TRANSFORMATIONS OF ORGANIC POLLUTANTS IN THE AQUATIC EN-VIRONMENT

Eidgenoessische Technische Hochschule, Zurich (Switzerland).

For primary bibliographic entry see Field 5B. W91-10316

ROLE OF EXTRACELLULAR ENZYMATIC REACTIONS IN NATURAL WATERS.

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. for Water Resources and Hydrodyn-

N. M. Price, and F. M. M. Morel.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 235-257. 6 fig. 1 tab, 57 ref. ONR Contract N-00014-80-C-0273. NSF Grant OCE 3-17532.

Descriptors: \*Biodegradation, \*Biotransformation, \*Environmental chemistry, \*Enzymes, \*Extracellular metabolism, \*Fate of pollutants, Algae, Aquatic bacteria, Chemical reactions, Diatoms, Kinetics, Phytoplankton, Trace elements.

# **Group 2K—Chemical Processes**

Aquatic microorganisms supply electrons through transplasmamembrane reductases to external sotranspinsinamentalities to the control and the control and other reactions on the cell surface, and are a source of dissolved extracellular enzymes. Both bound and dissolved extracellular enzymes are probably and dissolved extracellular elegibles are producily significant in maintaining a state of disequilibrium for some redox processes in natural waters and in accelerating some thermodynamically favorable reactions. In addition, these enzymes may also render the chemistry of the various components of aquatic systems highly interdependent. A diverse assemblage of phytoplankton and macroalgae, including diatoms coccolithophorids, charophytes and cyanobacteria reduce extracellular electron acceptors. In a culture medium in which Thalassio-sira weissflogii cells have grown and are then removed, dissolved solutes are present that reduce Cu complexes and Fe(III). Direct nonenzymatic reduction of metal complexes by the cell wall or cell membrane of T. weissflogii is evidenced in two ways. First, a nonlinear rate of Cu(BPDS)2 reducways. First, a nonlinear rate of CutBrDs/2 reduc-tion occurs initially after addition of the substrate. Second, this reductive capacity of the cells is sensi-tive to pretreatment with an oxidant such as Cu(II). Reduction of membrane-impermeable oxi-dants by intact cells of T. weissflogii occurs with-out the addition of extracellular reductants, by a process mediated by a transplasmamembrane redox system. Cell surfaces may also catalyze redox reactions at their surfaces without supplying the elec-trons from internal reductants as occurs in the extracellular L-amino acid oxidase of Pleurochrysis carterae. A variety of extracellular enzymes present in bacterioplantkon and phytoplankton such as alkaline phosphatase, carbonic anhydrase, urease, and proteases are not involved in redox reactions, but catalyze a variety of reactions. The reactions of ectoenzymes transform dissolved or-ganic nitrogen and phosphorus compounds and thus are intimately involved in the biogeochemical cycling of these elements. (See also W91-10309) (Geiger-PTT) W91-10317

AB INITIO QUANTUM-MECHANICAL CAL-CULATIONS OF SURFACE REACTIONS: A

Yale Univ., New Haven, CT. Kline Geology Lab. A. C. Lasaga, and G. V. Gibbs. IN: Aquatic Chemical Kinetics: Reaction Rates of

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 259-289. 20 fig, 3 tab, 24 ref.

Descriptors: \*Adsorption kinetics, \*Chemical reactions, \*Fate of pollutants, \*Geochemistry, \*Kinetics, \*Quantum mechanics, \*Surface processes, Adsorption, Hydrolysis, Minerals, Molecular structure, Silica, Structure-activity relationships.

Any quantitative study of heterogeneous kinetics must be based on a thorough understanding of the structure and dynamics of the mineral surfaces. The evaluation of potential surfaces is feasible at the level of the Born-Oppenheimer approximation where the positions of the nuclei are fixed and the Schroedingers nonrelativistic time-independent equation is solved for the wavefunction of the electrons. The ability to predict accurate potential surfaces allows investigations of the nature of the kinetic barriers, including the activated complexes, of key surface processes. With increases in computational power, it is now feasible to calculate abinitio potential surfaces that incorporate bond-breaking and bond-forming processes. The hydrolization of the Si-O-Si structural unit at the surface of silicates is a key step in the dissolution processes occurring at the surfaces of silicates. Water adsorption at the silica surface occurs most favorably as donor adsorption onto a silanol group. To ascertain the kinetics of the hydrolysis reaction, a computation of the activated complex is carried out by the linear synchronous transit method. (See also W91-10309) (Geiger-PTT)

ADSORPTION KINETICS OF THE COMPLEX MIXTURE OF ORGANIC SOLUTES AT MODEL AND NATURAL PHASE BOUND-ARIES. Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research. B. Cosovic.

Bi. Cosovic.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 291-310. 8 fig, 2 tab, 36 ref.

Descriptors: \*Adsorption, \*Adsorption kinetics, \*Boundary processes, \*Fate of pollutants, \*Kinetics, \*Organic compounds, \*Path of pollutants, \*Solutes, Air-water interfaces, Electrochemistry, Electrodes, Mass transfer, Organic matter; Structure-activity relationships.

Adsorption processes at natural phase boundaries occur from the aqueous phase containing complex mixtures of different organic and inorganic compounds which are not in equilibrium. Adsorption behavior of organic molecules can be described by competitive adsorption of the mixture, in which very often less adsorbable materials are present at higher concentrations and strongly adsorbable substances are present at lower concentrations. Since the adsorption process depends on both the ad-sorption constant and the adsorption kinetics, which include the mass transfer of adsorbable molecules from the bulk phase toward the surface as well as the intrinsic rate of attachment to the surface, the adsorption layer formed is influenced by qualitative and quantitative composition of the complex mixture of adsorbable solutes. The nonequilibrium adsorption of a number of mixtures of surface-active substances of interest for natural aquatic systems has been studied at the model phase nonpolar hydrophobic mercury electrode. Mass transfer of adsorbable molecules was controlled by diffusion and by convective processes. At the concentration level of naturally occurring organic substances diffusion controlled adsorption takes place within 10-1000 min, while convective movements accelerate it up to 100-1000 sec. Sec-ondary transformations of the adsorbed layer can be very slow and sometimes take place within hours, as was observed for valeric acid. Useful information on the adsorption behavior of the mixture and the structure of the adsorbed layer can be obtained by investigation of the influence of the adsorbed layer on the electrode processes of other ions and molecules, which are used as probe. Since nass and charge-transfer processes at the covered electrode surface depend on the porosity of the adsorbed layer and possible interaction between electroactive species and adsorbed molecules, the observed adsorption effect is indicative of the structure of the adsorbed layer as well as of the mechanisms of the exchange reactions at interfaces Electrochemical processes of the positively charged cadmium(II) ion and negatively charged nitrophenolate ion were used as the probe of choice. (See also W91-10309) (Geiger-PTT) W91-10319

REDOX REACTIONS OF METAL IONS AT MINERAL SURFACES,

Eidgenoessische Technische Hochschule, Zurich (Switzerland).
B. Wehrli.

D. Weitril.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 311-336. 9 fig, 4 tab, 58 ref.

Descriptors: \*Adsorption, \*Cations, \*Fate of pollutants, \*Metals, \*Minerals, \*Oxidation, \*Oxidation-reduction potential, \*Surface processes, Arsenic, Copper, Iron, Kinetics, Manganese, Vanadium.

Recent experimental evidence has shown that aqueous mineral surfaces provide additional accelerated pathways for redox processes such as the oxygenation of metal ions and the oxidation of organic pollutants. Iron and manganese particles often accumulate at redox boundaries and supply reactive mineral surfaces in zones with high chemical electron fluxes. In contrast to pyrite, the hydroxides of iron and manganese act as electron acceptors. An adsorbed reducing agent may follow two different pathways after electron transfer to these mineral surfaces. Oxidation products with high particle affinity such as Fe(III), Cr(III),

Co(III), and Sn(IV) will form strong surface complexes. Such an oxidative adsorption consumes the available mineral surface. If the oxidation products are anions such as Cr(VI), As(V) or organic compounds, which desorb more easily, the reactive interface is regenerated continuously and the reductive dissolution of the solid phase dominates the process. Acceleration of the Mn(II) oxygenation was observed in the presence of silica and alumina. Two complementary paradigms are used to describe the reactions at the mineral-water interface as an electrode and the picture of the mineral surface as a two-dimensional array of surface complexes. The relevant Fe(III)/Fe(II) equilibrium in most aquatic environments involves heterogeneous electron transfer between dissolved Fe(II) and the surface centers of iron oxyhydroxide particles. Alkali ions and inorganic anions such as NO3(-) and ClO4(-) adsorb electrostatically to mineral surfaces of opposite charge. Electron transfer between metal ions may occur as inner-sphere or as outer-sphere reactions. Outer-sphere electron transfers are simple reactions and can be described by the Marcus relations. The oxidation of V(IV), Fe(II), Mn(II), and Cu(I) involves a simple onelectron transfer step. The linear free energy relationship can be used in calculating the outer sphere reduction of molecular oxygen. Kinetic analysis has shown that adsorption induces a change in redox potential that is similar to the effect of one coordinated OH(-). As a consequence, surface complexes of Fe(II) and V(IV) exhibit a half-life close to that of the monohydroxo complexes. If the change in redox potential on adsorption can be verified independently, the simple relation between redox potential and log k described will allow surface oxygenation to be treated like an electrode reaction. (See also W91-10309) (Geiger-PTT)

MODELING OF THE DISSOLUTION OF STRAINED AND UNSTRAINED MULTIPLE OXIDES: THE SURFACE SPECIATION APPROACH.

Toulouse-3 Univ. (France).

J. Schot

In: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 337-365. 17 fig, 4 tab, 54 ref.

Descriptors: \*Dissolved solids, \*Geochemistry, \*Kinetics, \*Model studies, \*Oxides, \*Surface processes, \*Weathering, Basalts, Cations, Chemical speciation, Minerals, Theoretical analysis.

The treatment of surface titration data within the framework of transition-state theory is a promising method for elucidating and unifying the mechanisms of mineral dissolution in aqueous solutions. The transition-state theory was applied to model the dissolution of the complex oxide, Si3AlFe0.5Ca0.7Mg0.77Na0.33K0.03O10, which has several types of surface metal cation sites. Analysis of the dissolution and speciation data of this tholeite basalt glass and various oxides showed that the surface characteristics and the dissolution behavior of complex oxides can be modeled from the properties of their constituent oxide components. The dissolution rates of multiple oxides can be related to the abundance and speciation of hydrogen and hydroxyl radicals at different metal centers at the surface. Microbeam techniques disclosed two important findings concerning the steady-state dissolution of complex oxides: hydrogen-depth profiling performed on reacted aluminosilicates showed that the preferential removal of some metals proceeds via an exchange reaction with H(+) or H3O(+)/H2O and the silicate surfaces become protonated and/or hydrated to depths of several hundred angstroms or more depending on pH and temperature; and the formation of these altered layers does not involve a simple protonation mechanism of the surface. These kinetics were confirmed by the transition-state theory. Since dissolution is initiated by the adsorption of reactants at defects or active sites, experimental studies relating dissolution rates to defect concentrations are needed. Lattice defects may influence the rates of mineral dissolution by

# Chemical Processes—Group 2K

changing the bulk thermodynamic properties and by creating sites of accelerated dissolution on the solid surface. (See also W91-10309) (Geiger-PTT) W91-10321

DISSOLUTION OF OXIDE AND SILICATE MINERALS: RATES DEPEND ON SURFACE SPECIATION.

SPECIATION, Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland). W. Stumm, and E. Wieland. IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 367-400. 19 fig, 3 tab, 54 ref.

Descriptors: \*Geochemistry, \*Minerals, \*Oxides, \*Silicates, \*Surface processes, \*Weathering, Chemical speciation, Clay minerals, Hydroxides, Iron, Kinetics, Oxidation.

Surface structure is important in characterizing the surface reactivity and dissolution of oxide and slicate minerals. The surface complex-formation model accounts for specific chemical interactions at the solid surface. Formation of the surface species as the precursor of the activated complex is cies as the precursor of the activated complex is often the rate-determining step in the dissolution kinetics of many minerals. The general rate law for the dissolution of minerals is derived by considering established models of lattice statistics and activated-complex theory. The Madelung energy, defined as the energy that would be required to separate a particular ion (point charge) from its could be activated to a contribilities to the form separate a particular ion (point charge) from its equilibrium position in a crystalline structure to an infinite distance, is a promising parameter for estimating the activation energies of the dissolution process. Most oxides show the same trend with regard to the rate dependence on pH: a decrease in pH in the alkaline range. HCO3(-) enhances the dissolution rate of hematite. The dissolution rate of some dissolution rate of some dissolution and dependence of the dissolution rate of some dissolution. olivine and albite are enhanced by surface protona-tion and deprotonation. Complex-forming ligands promote the dissolution of clay minerals and change the stoichiometry of Al and Si release. During the weathering processes, the structure-forming cations may be detached from the mineral surface at the same rate (stoichiometric process) or at different rates (nonstoichiometric process). The PH dependence of kaolinite dissolution can be dis-cussed by expressing proton-promoted rates in cussed by expressing proton-promoted rates in terms of pH. The total excess proton density may be assigned to two successive protonation equilib-ria, the gibbsite surface or the edge surface, at the kaolinite surface. The mechanistic interpretation of kaolinite and muscovite dissolution includes: the kaolinite and muscovite dissolution includes: the dissolution controlled by the detachment of Al, surface protonation of the edge and of the gibbsite surface to promote the dissolution process, and reconstitution of a secondary Al phase. For the dissolution of Fe(III)(hydr)oxides, the rate of dissolution was found to be proportional to the concentration of the surface bound reductant. Along with weathering, other factors of fetting the hydrogenical control of the surface bound reductant. with weathering, other factors affecting the hydrowith weathering, other factors affecting the hydrogeochemical cycling of elements are: the lithosphere, the atmosphere, water and biota, which produces ligands and reductants. (See also W91-10309) (Geiger-PTT) W91-10322

PHOTOREDOX REACTIONS AT HYDROUS METAL OXIDE SURFACES: A SURFACE CO-ORDINATION CHEMISTRY APPROACH. Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

Dendorf (Switzerland).

B. Sulzberger.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 401-429. 11 fig, 66 ref.

Descriptors: \*Environmental chemistry, \*Oxidation, \*Oxidation-reduction potential, \*Photoreduction, Acidic water, Fate of pollutants, Iron, Kinetics, Light effects, Light intensity, Photo-

In photoredox reactions occurring at metal hy-droxide surfaces the efficiency of the interfacial

electron transfer depends on the type of surface coordination compound formed between a thermo-dynamically suitable ligand acting as electron donor or acceptor and a surface metal center. In donor or acceptor and a surface metal center. The photochemical reductive dissolution of hydrous Fe(III)oxide, the efficiency of detachment of reduced iron ions from the surface controls the overall kinetics of this process. The efficiency of detachment depends on the coordinative environ-ment of reduced surface iron centers and on the ment of reduced surface iron centers and on the crystallinity of the solid phase. Detachment of Fe(II) from the surface is in competition with reduction of adsorbed molecular oxygen. With Fe(III)hydroxide phases less crystalline than hematite, the inhibition of the photochemical reductive dissolution by oxygen is less pronounced. Since the rate of the photochemical reductive dissolution of Fe(III)hydroxides depends on the concentration and the extinction coefficient of the chromophore involved in the surface subtorgadox reaction, more involved in the surface photoredox reaction, more conclusive information is needed on the role of the surface complex as a chromophore. For such stud-ies, a suitable ligand would be one that forms an inner-sphere transfer band in a spectral window of the solid phase and is readily photolyzed. In the photic zone of a natural-water system dissolved Fe(II) can be formed via different pathways: via re(II) can be formed via unirerent patriways: via heterogeneous and via homogeneous photoredox reactions. Direct biological mediation of redox processes may lead to the formation of Fe(II). Fe(II) acts as a catalyst in the thermal dissolution of Fe(III)hydroxides. This FE(II)-catalyzed dissolution, of importance at the oxic-anoxic boundaries, may also be operative in the photic zone of a natural-water system and lead to autocatalytic dis-solution of Fe(III)hydroxides. The diurnal cycle of the Fe(II) concentration found in acidic waters is interpreted in terms of the photochemical reduc-tive dissolution of particulate iron and oxidation and precipitation of Fe[II]. It is expected that at a higher pH, usually encountered in surface waters, a light-intensity-dependent steady-state concentra-tion of Fe(II) is maintained by photochemical processes. (See also W91-10309) (Geiger-PTT) W91-10323

RATE AND MECHANISM OF DISSOLUTION OF CARBONATES IN THE SYSTEM CACO3-

Brussels Univ. (Belgium). Lab. d'Oceanographie.

R. Woilast. IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Sci-ence and Technology Series. John Wiley & Sons, New York. 1990. p 431-445. 6 fig, 1 tab, 26 ref.

Descriptors: \*Calcium carbonate, \*Carbonates, \*Fate of pollutants, \*Geochemistry, \*Kinetics, \*Magnesium carbonate, \*Minerals, \*Weathering, Aragonite, Calcite, Dolomite, Magnesite, Thermo-

Dissolution kinetics of single carbonates such as Dissolution kinetics of single carbonates such as calcite, aragonite, and magnesite exhibit simple dependence with respect to a limited number of reactants, specifically H(+), H2CO3, and H2O. This makes it easy to identify the elementary steps leading to the formation of the surface activated compiler and the nature of the products of the leading to the formation of the surface activated complex and the nature of the products of the detachment process following the decomposition of the activated complex. In contrast, the order of rate dependence of the dissolution of dolomite with respect to H(+) is fractional, as for many oxides and silicates, indicating more complex reactions at the mineral surface. A further elucidation of the cirin of this fractional order recurres a of the origin of this fractional order requires a better knowledge of the surface properties of the mineral and of the protonation reaction of the various surface sites. Classic acid-base titration of the surface of carbonates is difficult because of the high reactivity of these minerals and the complexof the dissolved carbonate system. Dissolution kinetics of a simple component close to saturation and the mechanism of the backward precipitation reaction are still subject to controversy. Minerals such as calcite and aragonite are known to rapidly reach a dissolution equilibrium when placed in closed aqueous systems. According to simple and classical thermodynamical concepts, this requires that each forward reaction be exactly balanced by a corresponding backward reaction. This condition introduces considerable constraints on the nature

of the backward reactions and on the value of the corresponding kinetic constant. This is not always observed experimentally because it is very likely that a rather disordered phase is first precipitated and that the system does not, in fact, approach a true equilibrium with the most stable solid phase on the time scale of the experiments. Various hyon the time scale of the experiments. Various ny-potheses concerning the properties of the solid-liquid interface and the composition of the double layer have been proposed in order to explain the observed kinetics. These hypotheses are consid-ered speculative as direct evaluations of properties of the mirral surface and of the interface are of the mineral surface and of the interface are severely lacking. (See also W91-10309) (Geiger-PTT) W91-10324

KINETICS OF COLLOID CHEMICAL PROC-ESSES IN AQUATIC SYSTEMS.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. C. R. O'Melia.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 447-474. 10 fig, 5 tab, 32 ref. EPA Grant R812760.

Descriptors: \*Colloids, \*Fate of pollutants, \*Kinetics, \*Particulate matter, \*Path of pollutants, \*Water chemistry, Aggregation, Aquifers, Coagulation, Epilimnion, Model studies, Sedimentation.

The availability of solid surfaces and the physical and chemical characteristics of solid/water interand chemical characteristics of solid/water inter-faces in aquatic environments can be determined by particle aggregation and deposition reactions. The kinetics of these colloid chemical reactions play an important role in the transport, reactivity, fate, and impact of pollutants and other particleand impact of pollutants and other partic reactive substances in natural waters. Particle transport has been described in field and laboratory experiments and in models to help elucidate the kinetics of particle aggregation and deposition in natural systems. Flow velocities of particles varied by about three orders of magnitude between labo-ratory and field experiments. The dominant masstransport mechanism in the aquifer tested was diffusion while direct interception determined trans-port of non-Brownian particles in laboratory experiments. The length of flow differed by over an order of magnitude between the two systems. The extent of particle removal or deposition was much less in the laboratory columns operated at high velocities than in the aquifer with a longer travel distance and a lower flow velocity. Despite all of these differences, the estimated values of particle transport agreed very well. Some laborato-ry determinations of attachment probabilities were used in modeling simulations of the kinetics and effects of colloid chemical processes in lakes using data from Lake Zurich. Field and laboratory studies were used to determined values of the attachment coefficient. Particle aggregation in Lake Zurich is considered to have an attachment probability of 0.1. When both coagulation and sedimenbility of 0.1. When both coagulation and sedimentation are occurring, smaller particles are removed from their size class by aggregation to larger size and then removed from the epiliminon to the bottom waters by gravity. Brownian diffusion, fluid shear, and differential sedimentation provide contact opportunities that can change sedimentation processes in a lake. The structure, chemistry and interaction of interfacial regions in an anauty. and interaction of interfacial regions in an aquatic environment can affect the kinetics of colloid chemical process in aquatic systems limiting the value of quantitative and even qualitative theoretical predictions of their kinetics. (See also W91-10309) (Geiger-PTT) W91-10325

KINETICS OF CHEMICAL WEATHERING: COMPARISON OF LABORATORY FIELD WEATHERING RATES.

Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5C.

# **Group 2K—Chemical Processes**

TRANSPORT AND KINETICS IN SURFICIAL

Northwestern Univ., Evanston, IL. Dept. of Geo-

A. Lerman.

IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 505-534. 5 fig, 6 tab, 67 ref.

Descriptors: \*Chemical reactions, \*Chemical transport, \*Environmental chemistry, \*Kinetics, \*Surface processes, \*Weathering, Carbonates, Erosion, Minerals, Runoff, Silicates.

Physical, hydrological, and chemical driving forces in the surficial environment control the progress of chemical reactions and material transprof fluxes of the reaction products. Physical and chemical reactions couple in mineral dissolution. Macroscopic transport of reaction products is af-fected by the coupling of hydrological and chemi-cal forces as in the mass flux of dissolved materials in water flow. The magnitudes of chemical kinetic and macroscopic transport processes indicate that great differences exist between the mineral dissolu-tion rates, as reported from laboratory measurements with silicates and carbonate minerals, and the rates derived from river-water composition and volume flow. An additional factor responsible for the faster rates of chemical weathering could be bacterial activity which varies from lower levels in the cold regions to higher levels in the tropics, in parallel with the rates of net primary productivity. A global mean for the rate of net chemical denuda-tion of the continental surface is about 14 micrometers/yr. The global continental surface is less re-sistant to corrosion than zinc and copper, but it is considerably more resistant than iron exposed to consideration more resistant than iron exposed to coastal oceanic and industrial-area atmospheric conditions. A linear dependence of the chemical weathering rates on water runoff may be accountweathering rates on water fundin may be accounted for by deeper percolation of water at high discharge volumes, resulting in a greater contact area with reactive mineral surfaces. The presentady flux of solids eroded from exposed rocks, sediments, and soils carries four to five times more mass than the flux of solutes in rivers, as reported by a number of investigators over a period of by a number of investigators over a period of years. Physical erosion is favored over chemical weathering by a combination of such factors as existence of a high relief on continents where about 25% of the nonglaciated surface occurs at elevations higher than 1000 m, and a relatively large fraction of the continental surface is covered to be existence to expect the surface of the continental surface is covered to the surface and only the surface is covered to the surface of the continental surface is covered to the surface of the continents of the surface is covered to the surface of by siliceous sediments and rocks, as compared to only about 16% of the nonglaciated area consisting of carbonate outcrops. The prevalence of the physically over chemically controlled mode of global material transport is a phenomenon of geologically long duration on scales of 1 to 10 million/yr. (See also W91-10309) (Geiger-PTT) W91-10327

REMOTE SENSING AND TRACE GAS FLUXES.

National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center. For primary bibliographic entry see Field 7B. W91-10381

# 2L. Estuaries

EFFECTS OF WEIR MANAGEMENT ON MARSH LOSS, MARSH ISLAND, LOUISIANA,

USA.

Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries.

J. A. Nyman, R. H. Charbeck, and R. G.

Environmental Management EMNGDC, Vol. 14, No. 6, p 809-814, November/December 1990. 2 fig, 34 ref

Descriptors: \*Aquatic habitats, \*Dam effects, \*Louisiana, \*Marsh management, \*Marshes, \*Resources management, \*Weirs, \*Wetlands, Aerial photography, Bayous, Canals, Lakes, Vegetation, Water birds.

Weirs are low-level dams traditionally used in Louisiana's coastal marshes to improve habitats for ducks and furbearing animals. Parts of Marsh Gucks and Turbearing animals. Parts of Marsh Island, Louisiana have been weir-managed since 1958 to improve the aquatic habitat. Using aerial photographs, marsh loss that occurred between 1957 and 1983 in a 2922 ha managed area was compared to that in a 2365 ha unmanaged area. Marsh loss was 0.38%/year in the weir-managed area, and a 0.35%/year loss in the unmanaged area. Because marsh loss in the two areas differed less than 0.19%/year, weirs did not appear to affect marsh loss. The increase in open water between 1957 and 1983 did not result from the expansion of lakes or bayous. Rather, solid marsh converted to broken marsh, and the amount of vegetation within previously existing broken marsh decreased. Solid marsh farthest from large lakes and bayous, and adjacent to existing broken marsh, seemed more likely to break up. Marsh Island has few canals; therefore, marsh loss resulted primarily from natural processes. Weirs may have different effects under different hydrological conditions; additional studies are needed before generalizations regarding weirs and marsh loss can be made. (Author's abstract) W91-09367

STUDY OF THE COMPOSITION AND DISTRI-BUTION OF LIGNIN IN RESUSPENDED AND PERMANENTLY SUSPENDED PARTICLES IN THE RIVER TAMAR ESTUARY.
Lancaster Univ. (England). Dept. of Environmen-

A. D. Reeves, and M. R. Preston. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 1, p 11-25, January 1991. 9 fig, 6 tab, 9 ref. National Environmental Research Council Grants GST/02/45 and GT4/84/AAPS

Descriptors: \*England, \*Estuaries, \*Lignin, \*Suspended sediments, \*Suspended solids, Angiosperms, Biodegradation, Buoyancy, Gymnosperms, Phenols, Settling, Tamar Estuary, Tidal cycle,

The composition and distribution of lignin in the permanently suspended and resuspended material permanently suspended and resuspended material of the Tamar Estuary have been investigated by separating particles on the basis of settling characteristics. Lignin was determined using the diagnostic phenols formed by copper oxide oxidation. Samples were collected over a tidal cycle at differsamples were confected over a man cycle at different depths at a single location and over a 30 km transect of the estuary at a constant depth. Summed values of lignin oxidation products in permanently suspended materials ranged from 0.90 to 10.49 mg, normalized to particulate organic carbon. These values are considerably higher than the range 0.22 to 3.87 mg measured in material resuspended as a result of tidal action. The different values reflect the relative buoyancy of the lignin-bearing materials. Ratios of the various lignin components suggest that the permanently suspended fraction contains a significant proportion of degraded angiosperm tissues, while in the resuspended fraction a component of degraded gymnosperm material is indicated. (Author's abstract) W91-09369

IMPORTANCE OF A WINTER DINOFLAGEL-LATE-MICROFLAGELLATE BLOOM IN THE

PATUXENT RIVER ESTUARY.
Academy of Natural Sciences of Philadelphia,
Benedict, MD. Benedict Estuarine Research Lab. Benedict, M.D. Benedict Estuarine Research Lab. K. G. Seliner, R. V. Lacoutre, S. J. Cibik, A. Brindley, and S. G. Brownlee. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 1, p 27-42, January 1991. 5 fig, 4 tab,

Descriptors: \*Algal blooms, \*Chesapeake Bay, \*Dinoflagellates, \*Estuaries, \*Patuxent Estuary, \*Phytoplankton, Aquatic habitats, Food chains, Limiting nutrients, Nutrient concentrations, Population density, Population dynamics, Seasonal dis-

A dense bloom of Katodinium rotundatum was observed in the Patuxent River estuary from December to February 1989. The dinoflagellate don cember to reorizaty 1995. The ulmonlagelinate dominated phytoplankton densities reached 1,000,000 cells/L and contributed up to 1900 microg carbon/L in near-surface depths. The bloom maintained a distinct patch extending over 10 to 25 km of the estuary or approximately one-third to one-half of the total estuary (salinities from 5 to 13 ppt) and other restricted to receive in the property of the the total estuary (sammues from 3 to 1 ppp) and was restricted to regions immediately upriver of the transition between the shallow upriver (3 to 4 m) and deeper lower estuary (> 10 m). Daily measurements collected in the primary bloom area at the same time each day in the study area indicated of the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated to the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area indicated the same time each day in the study area. 80-fold and 120-fold variations in chlorophyll and cell densities from day to day. Densities of potencell densities from day to day. Densities of potential grazers in the region were high with rotifers, primarily Synchaeta baltica, reaching densities of 1000/L in early winter, and the copepod Eurytemora affinis reaching levels exceeding 115,000/cubic m in February. Estimates of grazing pressure by these planktonic herbivores indicated substantial grazing losses for the bloom, with up to 67% of bloom biomass consumed per day in February. Nutrient concentrations and ratios of N/P during the bloom suggested potentially nitrogen-limited conditions; bloom demise was coincident with a shift to high N/P ratios and high river flows. These data as well as other historical data suggest that dinoflagellate blooms in the lower Patusent that dinoflagellate blooms in the lower Patuxent River estuary could be the primary source of carbon to the system during the winter and supply a large reservoir of labile organic matter to the planktonic secondary producers prior to annual spring diatom blooms in the region. (Author's ab-

W91-09370

WATER TRAPPING BY SEAGRASSES OCCU-PYING BANK HABITATS IN FLORIDA BAY. National Audubon Society, Tavernier, FL. Research Dept.

G. V. N. Powell, and F. C. Schaffner.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 1, p 43-60, January 1991. 12 fig, 3 tab,

Descriptors: \*Aquatic habitats, \*Florida, \*Florida Bay, \*Mud flats, \*Sea grasses, \*Wetlands, Carbonates, Desiccation, Drainage basins, Fish, Invertebrates, Meadows, Predation, Tidal effects, Water

Seagrasses, largely Thalassia testudinum, occupy habitats atop shallow (<0.5 m deep) carbonate mudbanks adjoining basins up to 3 m deep in Florida Bay. The phenomenon of water trapping whereby, during low tides, the seagrass meadow matrix retains a thin (< 20 cm) layer of water high on the bank too despris water layed in the adjoinon the bank top despite water levels in the adjoining basins being some 25 to 70 cm lower was quantified. The matrix slows water flow off the banks such that changes in the rate at which water banks such that changes in the rate at which water recedes through time approximates a sigmoid func-tion of water level. A meadow with a large sea-grass standing crop (59.0 g dry mass/sq m) held a 17.4 cm layer of water atop the bank, while a meadow of lesser standing crop (less biomass per area, 13.0 g dry mass/sq m) that may have been facilitated by a topographical berm held just 3.3 cm of water. Similarly, on the bank slope the higher standing crop meadow held 10.4 cm water nigher standing crop meadow held 10.4 cm water while the bank slope meadow at the site with lesser standing crop held only 1.6 cm water. Water trapping by seagrasses can keep water on the banks for up to 8 hours during low tides, preventing desiccation of the bank, and thereby providing permanent habitat for a diverse community of epibenthic fishes and invertebrates. The water trapping phenomenon presumably enhances overall prev shurnames and invertebrates. The water trapping phenomenon presumably enhances overall prey abundance and diversity, and regulates the temporal patterns of prey exposure to different types of predation risk, e.g. to wading birds versus predatory fishes. (Author's abstract)
W91-09371

FACTORS INFLUENCING THE SOIL SALINI-TY REGIME ALONG AN INTERTIDAL GRA-

Delta Inst. for Hydrobiological Research, Yerseke J. de Leeuw, A. van den Dool, W. de Munck, J.

# Estuaries—Group 2L

Nieuwenhuize, and W. G. Beeftink. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 1, p 87-97, January 1991. 6 fig, 2 tab, 21 ref.

Descriptors: \*Estuaries, \*Intertidal areas, \*Rainfall, \*Saline soils, \*Salt marshes, \*Wetlands, Drought, Ecosystems, Flooding, Fluctuations.

The influence of estuarine waters and rainfall defi-cit on top soil (0-5 cm) salinity was investigated for 23 stations situated along an intertidal gradient sampled at monthly intervals over a 4-year period. Up to a level half-way between mean sea level (MSL) and mean high water (MHW) soil salinity was strongly correlated with fluctuations in inun-dation water salinity. On average, 80% of the variation could be explained by this fluctuation. The impact of the estuarine waters on sediment salinity decreased above this level and dropped below significance level at 58 cm above MHW. The correlation between the rainfall deficit over the five days prior to soil sampling and soil salinity was significant at site elevations of 4 cm below MHW and higher. These results suggest that functioning of salt marsh ecosystems occurring below MHW will not be affected by precipitation or drought. (Author's abstract) W91-09372

ESTIMATING THE NON-ADVECTIVE TIDAL EXCHANGES AND ADVECTIVE GRAVITATIONAL CIRCULATION EXCHANGES IN AN ESTUARY.

Dartmouth Coll., Hanover, NH. Dept. of Earth

C. B. Officer, and D. R. Kester. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 1, p 99-103, January 1991. 2 fig, 1 tab,

Descriptors: \*Estuaries, \*Flushing, \*Residence time, \*Saline-freshwater interfaces, \*Tidal currents, Estimating, Freshwater, Mathematical models, Model studies, Salinity, Water column.

The flushing or residence time is the average lifetime of a particle in a given volume of the estuary, and can be calculated conveniently from the freshwater volume of the estuary. The flushing rate is defined as the rate at which the index quantity is exchanged to the ocean reservoir. The quantities needed for this determination are freshwater inputs needed for this determination are freshwater inputs to the estuary at various times during the year and the corresponding values of the average salinity within the estuary and the salinity within the adjacent ocean reservoir. To first-order effects the tidal exchange flux should be independent of the freshwater input to the estuary. The gravitational circulation flux is dependent on the freshwater input in setting up and maintaining the longitudinal density gradient that controls the resultant down-estuary circulation in the upper portion of the water column and the corresponding up-estuary circulation in the lower portion of the water column. (Brunone-PTT)

FIELD MEASUREMENT OF SPECIFIC GROWTH RATE, BIOMASS, AND PRIMARY PRODUCTION OF BENTHIC DIATOMS OF SAVIN HILL COVE, BOSTON.

Massachusetts Univ. at Boston. Environmental Sci-

D. M. Gould, and E. D. Gallagher. Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1757-1770, December 1990. 3 fig, 4 tab, 42

Descriptors: \*Algal growth, \*Biomass, \*Diatoms, \*Massachusetts, \*Primary productivity, Algal blooms, Benthic organisms, Boston Harbor, Carbon radioisotopes, Chlorophyll a, Intertidal areas, Savin Hill Cove, Seasonal distribution, Tides

Carbon-14 labeling of chlorophyll a and subsequent extraction by high-pressure liquid chromatography was adapted for field measurement of both specific growth rate and biomass of diatom films found on muddy intertidal sediments of Savin

Hill Cove, a small embayment of northwest Dor-chester Bay, Boston Harbor. Primary production was measured concurrently via carbon-14 uptake into total cellular carbon. An incubation apparatus that into total cellular carbon. An incubation apparatus that incorporates stirring to enhance sediment-water gas exchange was used at both low and high tides. Over the year-long study period (August 1987 to August 1988) measured specific growth rates were low (0.06 to 0.27/day) while biomass estimates were high (.000221 to .00154 g carbon/sq cm). Carbon:chlorophyll ratios were found during the 1988 spring bloom. The very low specific growth rates measured during the spring bloom (0.06 and 0.09/day) coupled with spring locreases in the numbers of grazers may explain the steep decline in biomass that followed the spring bloom in 1986 to 1988. (Author's abstract)

NITROGENASE ACTIVITY OF MICROCO-LEUS LYNGBYACEUS MAT COMMUNITIES IN A EUTROPHIC, TROPICAL MARINE EN-VIRONMENT.

Puerto Rico Univ., Mayaguez. Dept. of Marine Sciences.

For primary bibliographic entry see Field 5C. W91-09414

NITROGEN, PHOSPHORUS, AND NITROGEN FIXATION IN LACUSTRINE AND ESTUA-RINE ECOSYSTEMS,

North Carolina Univ. at Chapel Hill. Dept. of Biology. V. H. Smith.

Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1852-1859, December 1990. 8 fig, 23 ref. NSF Grant BSR 87-17638.

Descriptors: \*Cyanobacteria, \*Estuaries, \*Estuarine environment, \*Lacustrine environment, \*Limiting nutrients, \*Nitrogen, \*Nitrogen fixation, \*Phosphorus, Algal blooms, Algal growth, Comparison studies, Nutrient concentrations, Phytoplankton, Statistical analysis, Subtropical regions, Teorical regions, Tropical regions.

Cyanobacterial nitrogen fixation is an important biochemical mechanism that can confer significant competitive advantage to planktonic nitrogen-fixing cyanobacteria during nitrogen limitation. The hypothesis that low N:P supply ratios should result in nitrogen limitation of phytoplankton growth and should therefore be associated with blooms of nitrogen-fixing cyanobacteria in lakes growth and should therefore be associated with blooms of nitrogen-fixing cyanobacteria in lakes and estuaries was tested using data from both lakes and estuaries. A plot of data from 21 north temperate, subtropical, and tropical lakes initially suggested a weak inverse relationship between N:P loading ratios and annual rates of nitrogen fixation. This relationship was not statistically significant, however, and the apparent trend was found to be due to elevated values from one subtropical and one tropical lake. When these tropical and subtropical data were excluded, no significant relations of the propriet of the subtropical data were excluded, no significant relations. one tropical lake. When these tropical and sub-tropical data were excluded, no significant rela-tionship was evident for north temperate lakes alone. A test of the hypothesis that a strong posi-tive correlation should exist between annual rates of nitrogen fixation (NFIX) and growing season mean concentrations of total phosphorus (TP) re-vealed a highly significant unimodal relationship between NFIX and TP. These results suggest that nitrogen fixation by heterocystous cyanobacteria is light-limited due to a requirement for photosynthe-tically produced reductant, and that the subsequent decline in areal nitrogen fixation is due to succestically produced reductant, and that the subsequent decline in areal nitrogen fixation is due to successional changes in phytoplankton community structure during eutrophication, with a peak biomass of nitrogen-fixing cyanobacteria occurring at intermediate levels of phosphorus enrichment. Concentrations of TP are of overriding importance in regulation are for interest feature in the product of lating rates of nitrogen fixation in a broad spectrum of lakes and estuaries worldwide. (Brunone-PTT) W91-09417

MODELLING THE BEHAVIOUR OF OIL SPILLS IN ICE-INFESTED WATERS. Atmospheric Environment Service, Downsview (Ontario).

For primary bibliographic entry see Field 5B. W91-09420

DISTRIBUTION OF ACTINOMYCETES IN NEAR-SHORE TROPICAL MARINE SEDI-

MENTS.
Scripps Institution of Oceanography, La Jolla, CA.
P. R. Jensen, R. Dwight, and W. Fenical.
Applied and Environmental Microbiology
AEMIDF, Vol. 57, No. 4, p 1102-1108, April 1991.
4 fig, 2 tab, 23 ref. NSF Grants CHE86-20217 and
CHE90-08621; NCI Grant CA 44848.

Descriptors: \*Actinomycetes, \*Bacteria, \*Ecological distribution, \*Marine bacteria, \*Marine sediments, Bacterial growth, Bacterial physiology, Bahamas, Culturing techniques, Islands, Microbiological studies, Physiological ecology, Population density, Salinity, Seawater, Water depth.

Actinomycetes were isolated from near-shore marine sediments collected at 15 island locations throughout the Bahamas. A total of 289 actinomythroughout the Bahamas. A total of 289 actinomycete colonies were observed, and all but could be
assigned to the suprageneric groups actinoplanetes
and streptomycetes. A bimodal distribution in the
actinomycete population in relation to depth was
recorded, with the maximum numbers occurring in
the shallow and deep sampling sites. This distribution can be accounted for by a rapid decrease in
streptomycetes and an increase in actinoplanetes
with increasing depth and does not conform to the
theory that actinomycetes isolated from marine
sources are of terrestrial origin. Sixty-three of the
isolated actinomycetes were tested for the effects
of seawater on growth. Streptomycete growth in
nonsaline media was reduced by 39% compared
with that in seawater. The actinoplanetes had a
near obligate requirement of seawater for growth, near obligate requirement of seawater for growth, near of ongate requirement of scawater for growth, and this is presented as evidence that actinomycetes can be physiologically active in the marine environment. A number of problems regarding the enumeration of actinomycetes were encountered. enumeration of actinomycetes were encountered.

One problem is caused by the relatively low numbers and slow growth of actinomycetes in relation to many common unicellular bacteria. Another is that actinoplanete counts were not quantitatively correlated when serial dilution and plating tech-niques were used. (Doria-PTT) W91\_09446

ENZYME IMMUNOASSAY FOR IDENTIFICA-TION OF VIBRIO VULNIFICUS IN SEA-WATER, SEDIMENT, AND OYSTERS.

Food and Drug Administration, Dauphin Island, AL. Fishery Research Branch. For primary bibliographic entry see Field 5A. W91-09450

CHANGES IN MISSISSIPPI RIVER WATER QUALITY THIS CENTURY: IMPLICATIONS FOR COASTAL FOOD WEBS.

siana State Univ., Baton Rouge. Coastal Ecology Lab. For primary bibliographic entry see Field 5C. W91-09451

HYDROGRAPHIC, BIOLOGICAL AND NUTRIENT PROPERTIES OF TOMALES BAY, CALIFORNIA, MARCH 1995 TO MAY 1996.
Geological Survey, Menlo Park, CA. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-09483

COMPARISON OF RECORDING CURRENT METERS IN SHALLOW WATERS OF SAN FRANCISCO BAY, CALIFORNIA. Geological Survey, Sacramento, CA. Water Re-

sources Div. For primary bibliographic entry see Field 7B. W91-09526

CHESAPEAKE BAY'S HIDDEN TRIBUTARY: SUBMARINE GROUNDWATER DISCHARGE. Virginia Polytechnic Inst. and State Univ., Blacks-

#### Field 2—WATER CYCLE

# **Group 2L—Estuaries**

burg. Dept. of Biology. For primary bibliographic entry see Field 2F, W91-09630

EVALUATION OF PATAPSCO AQUIFER HY-DRAULICS BY TIDAL FLUCTUATION RE-

O'Brien and Gere Engineers, Inc., Syracuse, NY. For primary bibliographic entry see Field 2F. W91-09633

GROUNDWATER NON-POINT SOURCES OF NUTRIENTS TO THE SOUTHERN CHESA-PEAKE BAY.

Virginia Inst. of Marine Science, Gloucester Point. For primary bibliographic entry see Field 5B. W91-09634

HYDROCHEMICAL PROCESSES AFFECTING CONTAMINANTS NEAR THE GROUND-WATER/SURFACE-WATER INTERFACE, ABERDEEN PROVING GROUND, MARYLAND. Geological Survey, Towson, MD. For primary bibliographic entry see Field 5B. W91-09638

SIMULATION OF BRACKISH-WATER FLOW IN THE AQUIA AQUIFER, KENT ISLAND, MARYLAND.

Maryland Geological Survey, Baltimore. For primary bibliographic entry see Field 2F.

SUMMARY OF BRACKISH-WATER INTRU-SION IN COASTAL PLAIN AQUIFERS, NORTHERN CHESAPEAKE BAY AREA, MARYLAND.

Geological Survey, Towson, MD. For primary bibliographic entry see Field 2F. W91-09640

DIATOM FRUSTULES AS NATURAL TRACERS TO DETERMINE THE ORIGIN OF SUSPENDED MATTER IN THE WESER ESTUARY.

Bremen Univ. (Germany, F.R.).
B. Schuchardt, and M. Schirmer.
Environmental Technology (Letters) ETLEDB,
Vol. 11, No. 9, p 853-858, 1990. 4 fig, 26 ref.

Descriptors: \*Diatoms, \*Environmental tracers, \*Germany, \*Path of pollutants, \*Saline-freshwater interfaces, \*Sediment transport, \*Suspended sediments, Estuaries, Marine sediments, Sediment distribution, Sediments, Weser Estuary.

Although the occurrence of marine diatom frustules in tidal freshwater sediments has been documented, no quantitative data currently exists on the distribution of these organisms between marine sediment and suspended particulate matter (SPM). The axial distribution of Triceratium favus frustules in the SPM from the Weser estuary in Germany was quantitatively determined, and their po-tential value, particularly of the > 63 microm fraction, as natural tracers for upstream transport across the freshwater-seawater interface was demonstrated. Due to the seasonality of river discharge there is also a seasonal pattern of frustule density. At the upstream stations there was a close inverse correlation with the number of frustules and river discharge; most clearly seen during the autumn 1986 for a low discharge situation and in April 1986 for a high discharge situation. This is not only a result of the upstream migration of the turbidity maximum (increase of SPM concentration and Trimaximum (increase of SPM concentration and Tri-ceratium numbers per liter) but it also indicates changes in the composition of the SPM (increasing number of frustules/g SPM). The river discharge dynamics result in strong variations of Triceratium counts from month to month and between years, demonstrating the variability of SPM composition within the Weser Estuary. Due to the conse-quences of the landward transport of marine SPM on the distribution of heavy metals in astrocies, it on the distribution of heavy metals in estuaries, it would be useful when analyzing axial or seasonal concentration gradients of heavy metals in estu-aries, to routinely determine the proportion of marine versus fluvial SPM. (D'Agostino-PTT)

W91-09662

STIMULATION OF PHYTOPLANKTON PRO-DUCTION IN COASTAL WATERS BY NATURAL RAINFALL INPUTS: NUTRITIONAL AND TROPHIC IMPLICATIONS.

North Carolina Univ. at Chapel Hill. Inst. of Marine Sciences. For primary bibliographic entry see Field 2B. W91-09680

COASTAL MANAGEMENT IN THE USSR: PERESTROIKA ON THE COAST. Geographical Department, Moscow State University and Gomel Cooperative Institute, Byelorussia,

For primary bibliographic entry see Field 6E. W91-09694

UTILIZATION AND MANAGEMENT OF COASTAL AREAS IN KUWAIT. Kuwait Inst. for Scientific Research, Safat. Envi-

ronmental and Earth Sciences Div. For primary bibliographic entry see Field 6B. W91-09695

LONG-TERM LONG-TERM ANNUAL AND SEASONAL TRENDS IN SURFACE SALINITY OF SAN

FRANCISCO BAY.
J. P. Fox, T. R. Mongan, and W. J. Miller.
Journal of Hydrology JHYDA7, Vol. 122, p 93117, January 1991. 7 fig. 3 tab, 48 ref.

Descriptors: \*Bays, \*Estuaries, \*Salinity, \*San Francisco Bay, \*Water circulation, Mathematical studies, Saline-freshwater interfaces, Seasonal vari-ation, Statistical analysis, Upwelling, Water cur-

Trends in surface salinity at seven stations in San Trencisc in surface sainity at seven stations in San Francisco Bay were studied. Long-term surface salinity records were analyzed to quantify annual and seasonal trends. The study was designed to answer three questions: (1) have decreases in delta outflow caused the salinity of the San Francisco Bay to increase; (2) have changes in delta outflow altered the seasonal patterns of salinity; and (3) have changes in oceanic conditions contributed to changes in Bay salinity. It was found that annual surface salinity over the period 1920-1986 had slightly increased at the ocean boundary and slightly decreased at the river boundary. None of these trends were statistically different from zero even though upstream water use has nearly doubled. However, statistically significant seasonal trends were found. In most areas, salinity had increased from February through June and de-creased at other times. Salinity in the Bay is affected primarily by freshwater inflow and oceanic conditions. Seasonal salinity trends at stations near the freshwater boundary are probably largely due to the operation of upstream water projects, which have redistributed freshwater between the months. At stations near the ocean, seasonal salinity trends appear to be strongly influenced by offshore condi-tions, including a local rise in sea level and in-creased upwelling. (Agostine-PTT) W91-09738

BIAS ERROR IN MAXIMUM LIKELIHOOD ESTIMATION.

Exxon Production Research Co., Houston, TX. Offshore Div. For primary bibliographic entry see Field 7C. W91-09747

COASTAL ZONE TOURISM: A POTENT FORCE AFFECTING ENVIRONMENT AND SOCIETY. Washington Univ., Seattle. Inst. for Marine Stud-

For primary bibliographic entry see Field 6G. W91-09755

OCCURRENCE OF INTERSEXUALITY IN HARPACTICOID COPEPODS AND ITS RELATIONSHIP WITH POLLUTION.

Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Biological Sciences For primary bibliographic entry see Field 5C.

W91-09759

REACTIONS OF SAND SMELT TO LOW PH SEA-WATER.

National Power, Fawley (England). Marine Biol-For primary bibliographic entry see Field 5C. W91-09760

RELATIONSHIPS BETWEEN HEAVY METAL CONTENT AND BODY WEIGHT OF FISH FROM THE KELANG ESTUARY, MALAYSIA. Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science.

For primary bibliographic entry see Field 5B. W91-09763

TURBULENT MIXING AT FRESHWATER/ SALTWATER INTERFACES.

California Inst. of Tech., Pasader E. J. List.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-162267. Price codes: A04 in paper copy; A01 in microfiche. Final Report, 1991. 50p. 28 fig. 13 ref, append. USGS Contract No. 14-08-0001-G1628.

Descriptors: \*Saline-freshwater interfaces, \*Simulation, \*Density-stratified flow, \*Turbulent flow, \*Mixing processes, Fluid velocity, Density distribution, Laser measurements, Entrainment.

The primary objective of the work proposed is to develop a usable and verified theory of mixing in density-stratified fluids that can be implemented in computer models of estuarine processes. Turbulent mixing processes in density stratified flows have been evaluated in hydraulic laboratory simulations of actual interfacial flows. These simulations have of actual interfacial flows. These simulations have been carried out in a specially constructed labora-tory channel that is equipped with laser-based measuring equipment. This equipment enables non-intrusive measurements of fluid velocities and den-sity distributions within the density-stratified flows, which have been rendered optically homogeneous by refractive index matching of the fluids used. The results of these studies have indicated that there are two basics features of such flows to be considered. One is the overall flow configuration for the density-stratified fluids. When two fluids of differing density flow in opposite directions at different elevations, such as in a river estuary, it has been found that there are four different overall configurations that the flow field can adopt. The second basic feature concerns the details of the processes that mix fluid of one layer into the other layer. The results of the research indicate that there are several different mechanisms that are involved in this process and that the mixing is clearly not independent of the overall flow configuration that is present. A general theory to describe both the flow fields and the mixing has been developed and experimentally verified in the condition where the entrainment occurs primarily in a supercritical internal flow. An extension to the more difficult case of entrainment into subcritical flows is still in development. (USGS) W91-09859

ACCUMULATION OF METAL RADIO-TRACERS BY MYTILUS EDULIS.
International Lab. of Marine Radioactivity,

Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5A. W91-09928

APPROACH TO THE ECOLOGICAL SIGNIFI-CANCE OF CHEMICALLY MEDIATED BIOACTIVITY IN MEDITERRANEAN BENTHIC COMMUNITIES.

Consejo Superior de Investigaciones Cientificas, Gerona (Spain). Centro de Estudios Avanzados de

M. J. Uriz, D. Martain, X. Turon, E. Ballesteros,

and R. Hughes. Marine Ecology Progress Series MESEDT, Vol. 70, No. 2, p 175-188, 1991. 9 fig, 4 tab, 54 ref.

Descriptors: \*Mediterranean, \*Benthos, \*Biofouling, Cytotoxicity, Tunicates, Bryozoans, Bactericides, Fungicide, Viricides.

Possible ecological roles of antibacterial, antifungal, antiviral, cytotoxic and antimitotic activities found in western Mediterranean benthos were investigated, and relationships were sought between these activities and taxonomic groups, presence of fouling organisms, and community structure. Cyto-toxic and antimitotic activities were the most abundant, and were widespread in almost all the taxo-nomic groups studied. Porifera, Bryozoa and Tuni-cata contained the most biologically active chemi-cals. Cytotoxic molecules were more frequently present in tunicates than bryozoans. There was a close association between antimitotic and cytotoxic, as well as between antibacterial and antifungal activities. As antifouling defenses, cytotoxic and antimitotic activities seemed to be less effective than antibacterial and antifungal ones; the uve unan antibacterial and antifungal ones; the latter appeared to function in a generalist antifouling mode. Chemically rich species were much more abundant in sciaphilic/cryptic habitats than in photophilic ones. (Author's abstract) W91-09929

MICROBIAL GROWTH AND ACTIVITY DURING THE INITIAL STAGES OF SEAGRASS DECOMPOSITION.

Virginia Univ., Charlottesville. Dept. of Environ-

. K. Blum, and A. L. Mills. Marine Ecology Progress Series MESEDT, Vol. 70, No. 1, p 73-82, 1991. 3 fig, 1 tab, 46 ref.

Descriptors: \*Microbial degradation, \*Decomposition, \*Seagrass, Oxygen requirements, \*Marine bacteria, Food chains, Carbon, Carbon dioxide, Detritus, Bacterial physiology.

Conversion of the rapidly leached plant material to microbial cells by the community of microorga-nisms that is associated with the detritus during the initial stages of submerged litter decay was examinitial stages of submerged litter decay was examined. Microbial oxygen consumption and bacterial growth associated with decaying Zostera marina increased rapidly in the first 24 h of incubation at the sediment surface. During this period, the detrital complex lost 20% of its initial dry weight. An additional 20% of the original dry weight was lost in the next 13 d, and 73% was lost over the entire 6 wk incubation period. Changes in the rate of weight loss were consistent with changes in the patterns of bacterial activity. While the initial response of the detritus-associated bacteria was rapid and substantial, less than 7.5% of the detrital carbon lost during the first 48 h of incubation was metabolized (assimilated plus respired), although caroon tost during the lits 4 n of includation was metabolized (assimilated plus respired), although 52.6% was metabolized during the 28 d to 42 d period. Of the plant carbon metabolized, over 80% was mineralized to carbon dioxide. The results suggest that if bacterial transformation of plant litter is an important link in the transfer of pri production to aquatic food webs, water column bacteria function as a link and not the bacteria associated with detrital particles. (Author's abstract) W91-09934

POTENTIAL OF SOME CAROTENOIDS IN TWO RECENT SEDIMENTS OF KIEL BIGHT AS BIOGENIC INDICATORS OF PHYTODE-

Bremen Univ. (Germany, F.R.). Fachbereich 2 -Studiengang Biologie. D. Abel-Oeschger.

Marine Ecology Progress Series MESEDT, Vol. 70, No. 1, p 83-92, 1991. 8 fig, 1 tab, 34 ref.

Descriptors: \*Bioindicators, \*Germany, \*Carotenoids, \*Pigments, \*Detritus, Chlorophyll a, Xanthophylls, Beta carotene, Lutein, Fucoxanthin, Peridinin, Marine sediments, Sedimentation, Algae, Macrophytes, Phytoplankton.

Carotenoids are routinely used as biogenic markers for plant debris in the marine environment. But,

like the chlorophylls, carotenoids suffer chemical alteration and even hydrolization to colorless end-products when detritus is metabolized by animals products when detritus is metabolized by animals and bacteria in the water column. The stability of pigments after deposition in surface sediments was investigated. In a laboratory experiment using oxic sediment, the carotenoid lutein exhibited greater stability against chemical and microbial breakdown than chlorophyll a, which has a half-life of only 3 wk under oxic conditions. In situ investigations in wk under oxic condutions. In situ investigations in anoxic mud sediments in Kiel Bight, Germany, showed rapid disintegration of polar xanthophylls and chloropigments. Beta carotene and lutein were relatively stable in anoxic sediment. Data from a 1 yr field study at 2 stations in Kiel Bight are report of the asplicability of carotenoid pigments as biogenic markers in sediments. Advective transport of macrophyte debris was investigated by measuring the concentration of lutein in different sediments on a down-slope transect. Lutein exhibited a pattern of slowly increasing red macrophyte input to the muddy sediments, starting in autumn and continuing through winter; but it was not detected in shallow sand sediments near the growth sites of the algae. Fucosanthin and peridinin were found in both muddy and sandy sediment, reflecting sedimentation events resulting from transport of phytoplankton from the water column. (Author's abstract) W91-09935

COMMUNITY STRUCTURE OF CORAL REEFS WITHIN THE VICINITY OF MOTOBU AND SESOKO, OKINAWA, AND THE EFFECTS OF HUMAN AND NATURAL INFLU-

ENCES.
National Univ. of Singapore. Dept. of Zoology.
For primary bibliographic entry see Field 4C.
W91-09952

ALGAL CARBON-NITROGEN METABOLISM: A BIOCHEMICAL BASIS FOR MODELLING THE INTERACTIONS BETWEEN NITRATE AND AMMONIUM UPTAKE. Dunstaffnage Marine Research Lab., Oban (Scot-land)

K. J. Flynn. Journal of Plankton Research JPLRD9, Vol. 13, No. 2, p 373-387, March 1991. 2 fig, 84 ref.

Descriptors: \*Algal physiology, \*Ammonium, \*Aquatic environment, \*Carbon metabolism, \*Marine environment, \*Model studies, \*Nitrates, \*Nitrogen metabolism, Carbon fixation, Nitrogen stress, Phytoplankton, Respiration.

It is hypothesized that the regulation of the response by phytoplankton to nitrogen-stress centers directly or indirectly on the intracellular proportions of key metabolites of nitrogen and carbon metabolism, such as glutamine and 2-oxoglutarate, as has been demonstrated for bacteria. Many of the as has been demonstrated to roacteria. Many of the interactions between ammonium and nitrate assimilations, with respiration, CO2 fixation and nitrogen-stress, may be explained by such a mechanism. This mode of regulation allows a progressive response to stress by (in)activation and (de)repression of transport and assimilatory processes, with growth on excess ammonium causing maximum repression of the capacity to use other sources of nitrogen, such as nitrate. At the concentration of ammonium in marine waters, however, a measure of derepression is probably the norm, enabling a simultaneous uptake of several sources of nitrogen. (Author's abstract) W91-09956

DIRECTIONS OF SUCCESSION OF BALTIC

DERECTIONS OF SUCCESSION OF BALTIC VEGETATION,
Gdansk Univ. (Poland). Inst. of Oceanography. For primary bibliographic entry see Field 5C. W91-09984

DISTRIBUTION OF SHRIMP (PANDALUS BO-REALIS) LARVAE AND HYDROGRAPHIC PATTERN IN THE NORTHERN GULF OF ST. LAWRENCE.

Institut Maurice-Lamontagne, Mont-Joli (Quebec). For primary bibliographic entry see Field 8I.

W91-09991

TEMPORARY RESIDENCE BY JUVENILE SALMON IN A RESTORED ESTUARINE WET-

Washington Univ., Seattle. Fisheries Research

D. K. Shreffler, C. A. Simenstad, and R. M. Thom. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2079-2084, November 1990. 2 fig. 4 tab, 20 ref.

Descriptors: \*Estuaries, \*Fish migration, \*Salmon, "Washington, "Wetlands, Downstream, Fish behavior, Fish hatcheries, Fish larvae, Fisheries, Fyke nets, Monitoring, Puyallup River, Residence time, Tidal channels.

Juvenile Pacific salmon utilizing the recently restored Lincoln Avenue wetland system in the Puy-allup River estuary, Tacoma, Washington, were allup River estuary, Tacoma, Washington, were studied during the spring seaward migration in 1987 and 1988. Independent estimates of juvenile salmon wetland residence times were derived from: (1) fish that volitionally migrated downstream, were captured in the inlet-fyke net, were fin-clipped, passed over inlet fyke net into the wetland, and were recaptured in the outlet-fyke as they left the wetland; and (2) spray-marked fish, that were transported from the Puyallup Indian Tsibe's batchers; selected directly into one of the Tribe's hatchery, released directly into one of the tidal channels of the wetland, and recaptured in the tidal channels of the wetland, and recaptured in the outlet fyke net. Mark-recapture experiments indicated that 0.06% of the outmigrating juvenile chum salmon (Oncorhynchus keta) and 0.59% of the outmigrating juvenile chum salmon averaged approximately 2 days (range 1 to 9 days), and juvenile chinook salmon approximately 5 days (voiltional) and 38 days (spray-marked) (total range 1 to 43 days). The restored wetland system currently provides pahitst for the temporary residence of provides habitat for the temporary residence of migrating juvenile chum and fall chinook salmon, but rigorous evaluation of the benefit of residency is constrained by the lack of data from comparable natural wetlands. (Author's abstract) W91-09992

IMPACT AND IMPLICATIONS OF LARGE-SCALE ENVIRONMENTAL ANOMALIES ON THE SPATIAL DISTRIBUTION OF SPAWN-ING OF THE NAMIBIAN PILCHARD AND ANCHOVY POPULATIONS.

Sea Fisheries Research Inst., Cape Town (South Africa). F. Le Clus

South African Journal of Marine Science SJMSE7, Vol. 9, p 141-159, 1990. 11 fig, 5 tab, 66 ref.

Descriptors: \*Anchovy, \*Environmental effects, \*Fish populations, \*Fisheries, \*Pilchard, \*Population dynamics, \*Spatial distribution, \*Spawning, Biomass, Geographic distribution, Marine environment, Seasonal variation, Water temperature.

Trends in the spatial pattern of spawning of pilrends in the spatial pattern of spawning or pirchard Sardinops ocellatus and anchovy Engraulis capensis during the period 1971 to 1985 were examined in relation to large-scale environmental anomalies outside the spawning area. Shifts in the locality of peak spawning of anchovy often coincided with that of pilchard, although sometimes are below the statement of the second of the anchovy were slower to respond to an environ-mental change. With negative sea surface temperature (SST) anomalies spawning shifted northward, whereas with positive anomalies spawning took place both in the north and farther south. With a transition from negative SST anomalies early in the spawning season to zero to positive anomalies the spawning season to zero to positive anomalies later in the spawning season, the impact on ancho-vy and pilchard spawning differed. Anchovy spawning was either reduced or absent during the negative phase of transitional seasons, thus avoiding unfavorable conditions. Pilchard, on the other ing unfavorable conditions. Pilchard, on the other hand, were spawning mainly in the north during the negative phase of the transitional season, but also in the south during the zero to positive phase. These shifts in spawning locality in response to environmental anomalies outside the spawning area imply that an explanation for such shifts need not be sought in changes in biomass or age structure,

# Field 2-WATER CYCLE

# **Group 2L—Estuaries**

or in the fact that stocks may be genetically different. All of these theories have been previously advanced. (Author's abstract)

INTERANNUAL CHLOROPHYLL VARIABILITY IN SOUTH AFRICA'S SALDANHA BAY SYSTEM, 1974-1979.

ea Fisheries Research Inst., Cape Town (South Africa).

P. M. S. Monteiro, and G. B. Brundrit. South African Journal of Marine Science SJMSE7, Vol. 9, p 281-287, 1990. 4 fig, 12 ref.

Descriptors: \*Chlorophyll, \*History, \*Saldanha Bay, \*Temporal variation, Algal blooms, Coastal waters, Estuaries, Nitrates, Nutrient concentra-tions, Physical properties, Salinity, South Africa, Upwelling, Water chemistry, Water temperature.

Data obtained in the course of a pollution monitoring program in Saldanha Bay, South Africa, between 1974 and 1979, show that chlorophyll is affected by interannual variability in the characteristics of coastal water. Inflow of warm, oligotrophic oceanic water into the inshore zone in De-cember 1974 and 1976 caused a marked depression cember 1974 and 1976 caused a marked depression in the nitrate concentrations and in the expected chlorophyll concentrations at the time of the summer blooms. The timing of these inflows appears to influence the biosphere response, suggesting that annually or monthly averaged time-series may not always be appropriate for demonstrating links between biological variability and physical forcing; finer resolution may be required. The interest of distract hearing on see suffice temperated. impact of diurnal heating on sea surface tempera-ture may mask important source characteristics of the surface water. Salinity was found to be a more conservative property, which helped in interpreta-tion of variability. (Author's abstract) W91-10011

CHANGES IN ICHTHYOFAUNAL DIVERSITY AND ABUNDANCE WITHIN THE MBASHE ESTUARY, TRANSKEI, FOLLOWING CONSTRUCTION OF A RIVER BARRAGE.
Transkei Univ., Umtata (South Africa). Dept. of

Zoology.

For primary bibliographic entry see Field 6G. W91-10013

MANAGING TROUBLED WATERS: THE ROLE OF MARINE ENVIRONMENTAL MON-

National Research Council, Washington, DC. Committee on a Systems Assessment of Marine Environmental Monitoring. For primary bibliographic entry see Field 5G. W91-10061

HYDROLOGY OF COASTAL LOWLANDS-ANALYSIS OF PROBLEMS AND RESEARCH NEEDS.

For primary bibliographic entry see Field 2A. W91-10124

ASSESSMENT OF ENVIRONMENTAL SUIT-ABILITY FOR GROWTH OF ZOSTERA MARINA L. (EELGRASS) IN SAN FRANCISCO

BAY.
Chicago Univ., IL. Dept. of Molecular Genetics and Cell Biology.
R. C. Zimmerman, J. L. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn, and R. S. Alberte.
Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 353-366, March 1991. 5 fig. 3 tab, 39 ref. NOAA Grant No. NA85AA-D-SG140, NSF Grant OCE-8603369

Descriptors: \*Aquatic plants, \*Estuarine environ-ment, \*Light effects, \*San Francisco Bay, \*Spatial distribution, \*Turbidity, \*Zostera, Environmental effects, Nutrient concentrations, Photosynthesis, Plant growth, Primary productivity, Water depth.

The relationship between turbidity and light availability, and its subsequent effect on the depth dis-tribution of Zostera marina was investigated in San Francisco Bay. The average daily period of irradiance-saturated photosynthesis (H-sat) required for the maintenance of whole plant carbon balance and growth, based on measured rates of photosynthesis and respiration (as well as data available in the literature), were estimated to be between 3 and 5 hours. Estimates of average H-sat availability in the field were determined from laboratory measurements of the photosynthesis versus irradiance (P vs. I) response and from field observations of light attenuation measured at five sites in San Francisco Bay. Although plants were found to be low light adapted with regard to their P vs. I response, they were limited to depths shallower than 2 meters lower than mean lower low water at all times. This depth limit corresponded fairly well to predicted H-sat requirements at two sites where turbidity was relatively low and constant, but depth limits of eelgrass were less than 1.5 m at ree sites subjected to extremely turbid and variable light environments, much shallower than pre-dicted from calculations of mean daily carbon requirements and H-sat availability. Thus, in addition to the mean light environment, periods of extreme light attenuation that last from days to weeks may be important in controlling elegrass growth and productivity in highly turbid and dynamic estu-aries such as San Francisco Bay. (Author's ab-W91-10169

ARE SPARTINA MARSHES A REPLACEABLE RESOURCE: A FUNCTIONAL APPROACH TO EVALUATION OF MARSH CREATION EF-

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.

L. D. Moy, and L. A. Levin. Estuaries ESTUDO, Vol. 14, No. 1, p 1-16, March 1991. 11 fig, 3 tab, 44 ref.

Descriptors: \*Marshes, \*North Carolina, \*Salt marshes, \*Spartina, \*Wetland creation, \*Wetland sestoration, \*Wetlands, Dills Creek, Ecosystems, Fish diets, Population density, Sediment physical properties, Spawning, Species composition

Marsh creation has come into increasing use as a measure to mitigate loss of valuable wetlands. Sediment properties, infaunal community composition, and Fundulus heteroclitus marsh utilization were compared for a man-made Spartina salt marsh (between ages 1 to 3 years) in Dills Creek, North Carolina, and adjacent natural marshes to the east and west. East natural marsh and planted marsh sediment grain-size distributions were more similar to each other than to the west natural marsh due to shared drainage systems, but sedi-ment organic content of the planted marsh was much lower than in either natural marsh. The difference was reflected in macrofaunal composition. Natural marsh sediments were inhabited primarily by subsurface, deposit-feeding oligochaetes whereas planted marsh sediments were dominated by the tube-building, surface-deposit feeding poly-chaetes. Infaunal differences were mirrored in Fundulus diets. Though natural marsh fish may acquire a potentially less nutritive, detritus based diet relative to the higher animal protein diet of the planted marsh fish, Fundulus abundances were markedly lower in the planted marsh than in the natural marshes, indicating fewer fish were being supported. Lower Spartina stem densities in the planted marsh may have provided inadequate protection from predation and/or insufficient spawning sites for the fundulids. After three years, the planted marsh remained functionally distinct from the adjacent tidal marshes. Mitigation success at Dills Creek could have been improved by increasing tidal flushing, thereby enhancing access to marine organisms and by mulching with Spartina wrack to increase sediment organic matter content and porosity. Results from this study indicate that salt marshes should not be treated as a replaceable resource in the short term. The extreme spatial and temporal variability inherent to salt marshes make replacement of a marsh by planting one on another site virtually impossible. (Author's abstract) SEASONAL DISTRIBUTION OF SULFUR FRACTIONS IN LOUISIANA SALT MARSH SOILS.

Louisiana State Univ., Baton Rouge, Lab. for Wetland Soils and Sedin

N. Krairapanond, R. D. DeLaune, and W. H.

Estuaries ESTUDO, Vol. 14, No. 1, p 17-28, March 1991. 10 fig, 2 tab, 41 ref. Grant BSR-8414006 and BSR-8806601.

Descriptors: \*Aquatic soils, \*Louisiana, \*Salt marshes, \*Seasonal distribution, \*Soil chemistry, \*Sulfur, Chemical analysis, Distribution patterns, Pyrite, Soil analysis, Soil profiles, Sulfides.

The profile distributions of specific sulfur forms were examined at a site in Louisiana salt marsh over a 1-yr period. Soil samples were fractionated into acid-volatile sulfides, HCl-soluble sulfur, elemental sulfur, pyrite sulfur, ester-sulfate sulfur, carbon-bonded sulfur, and total sulfur. Inorganic sulfur constituted 16% to 36% of total sulfur, with partie sulfur representations 21% Parity sulfur, consulfur constituted 10% to 30% of total sulfur, with pyrite sulfur representing <2%. Pyrite sulfur content in marsh soil was relatively high in winter. Pyrite sulfur and elemental sulfur together accounted for 4% to 24% of the inorganic sulfur fraction. Between 74% and 95% of inorganic sulfur was present as the HCl-soluble sulfur form. A significant negative correlation between acid-volatile sulfides and elemental sulfur observed in summer suggested the transformation of sulfides to elemental sulfur. Organic sulfur, in the forms of ester-sulfate sulfur and carbon-bonded sulfur, pre-dominated in all sampling periods, comprising 64% to 84% of total sulfur. The conversion of ester-sulfate sulfur into carbon-bonded sulfur was more likely to occur in winter than in other seasons. Carbon-bonded sulfur accounted for 53% to 89% of the organic sulfur. Organic sulfur was the major contributor to the variation of total sulfur in all seasons studied. Total sulfur concentration showed a statistically significant increase with depth. (Author's abstract) W91-10172

CLAY MINERAL DISTRIBUTIONS AND SOURCE DISCRIMINATION OF UPPER QUA-TERNARY SEDIMENTS, LOWER CHESA-PEAKE BAY, VIRGINIA.

Delaware Univ., Lewes. Coll. of Marine Studies. S. A. Skrabal.

Estuaries ESTUDO, Vol. 14, No. 1, p 29-37, March 1991. 2 fig, 3 tab, 34 ref.

Descriptors: \*Chesapeake Bay, \*Clay minerals, \*Estuarine sediments, \*Sediment chemistry, \*Sediment sources, \*Sediment transport, \*Virginia, Continental shelf, Geologic history, Grain size, James River, Thimble Shoal Channel, Trace elements.

Discriminant function analysis of clay mineral data from five cores of upper Quaternary sediment indi-cates that marine inputs are a significant source of fine-grained sediment near Thimble Shoal Channel, a major natural channel in lower Chesapeake Bay. Illite, of predominantly marine origin, is found to be enriched in clay fractions of three cores adja-cent to the channel, relative to two cores near the mouth of the James River estuary. Thimble Shoal Channel is a significant repository and conduit for fine-grained sediment from the shelf. This result is ogous to previous results showing that the analogous to previous results showing that the shelf is the dominant source of fine sand in the lower bay. Sediment in Thimble Shoal Channel reflects a shelf source even at the landward end, an area which was previously thought to be dominat-ed by deposition from the James River. (Author's W91-10173

CHARACTERIZATION OF A MALAYSIAN MANGROVE ESTUARY.

University of Science, Penang (Malaysia). School of Biological Sciences.

J. E. Ong, W. K. Gong, C. H. Wong, Z. H. Din, and B. Kjerfve.

Estuaries ESTUDO, Vol. 14, No. 1, p 38-48, March 1991. 7 fig, 3 tab, 26 ref.

Descriptors: \*Estuarine environment, \*Malaysia, \*Mangrove trees, \*Rainfall distribution, \*Tides, Dispersion coefficient, Drainage effects, Runoff rates, Sungai Merbok Estuary, Tidal currents, Vertical stratification, Water circulation.

The Sungai Merbok estuary, in wet tropical Peninsular Malaysia, borders the Straits of Malacca. The mean annual rainfall in the catchment area is 2068 mean annual rainfall in the catchment area is 2068 mm, with a peak in September to October and a smaller peak in April. The Sungai Merbok estuary is characterized by a 1.7 m semidiurnal tide with a 0.16 form number, peak currents of 1.3 m/sec, and mean freshwater discharge of 20 sq m/sec. The system is classified as 2a/2b estuary or 1a/1b during periods of low runoff. Gravitational circulation is highly variable but coincides with the nean tion is highly variable (but coincides with the neap stratification) and vertical stratification varies from ol to 1. The estuary displays a pronounced for-nightly neap spring stratification-destratification cycle. The effective longitudinal dispersion coeffi-cient is approximately 100 sq m/sec. (Author's

# STRUCTURE AND DYNAMICS OF MANGROVE FORESTS ALONG A FLOODING GRA-

Universidad Nacional Autonoma de Heredia (Costa Rica). Escuela Ciencias Biologicas.

J. A. Jiminez, and K. Sauter. Estuaries ESTUDO, Vol. 14, No. 1, p 49-56, March 1991. 5 fig, 12 ref.

Descriptors: \*Costa Rica, \*Distribution patterns, \*Environmental gradient, \*Floods, \*Mangrove trees, Cohort analysis, Drought effects, Ecosystems, Plant growth, Population dynamics, Saline soils, Soil chemistry, Tidal inundation, Zonation.

The zonation patterns of Avicennia bicolor and Rhizophora racemosa were studied in a mangrove forest on the Pacific Coast of Costa Rica. Comparisons were made between the establishment, survival and growth of both species in three plots, I ha each, located along the flooding gradient. Based on cohort analysis and reciprocal planting observations, species zonation was primarily regulated by the depth of tidal inundation and the differential ability of the propagules to become established. However, tidal sorting was not the only operative factor related to inundation. Drought and probably high soil salinities limited the survival and growth of R. racemosa in the landward sections of the forest. Tidal sorting, however, confined propagules to zones where they The zonation patterns of Avicennia bicolor and ever, confined propagules to zones where they probably had the highest likelihood of contributing to another generation. (Author's abstract)
W91-10175

# DECOMPOSITION OF HUDSON ESTUARY MACROPHYTES: PHOTOSYNTHETIC PIG-MENT TRANSFORMATIONS AND DECAY

Thistitute of Ecosystem Studies, Millbrook, NY. T. S. Bianchi, and S. Findlay. Estuaries ESTUDO, Vol. 14, No. 1, p 65-73, March 1991. 5 fig. 2 tab, 59 ref. Hudson Estuary Foundation Grant No. 003/88A/007.

Descriptors: \*Chlorophyll, \*Decomposition, \*Emergent aquatic plants, \*Hudson Estuary, \*Litter, \*Submerged aquatic plants, Algal growth, Biogeochemical cycling, Diatoms, Ecosystems, Microorganisms, Pigment concentrations.

Plant pigment decay constants were determined for four macrophytes collected from the Hudson Estuary. Typha angustifolia and Scirpus fluviatilis were used as representatives of emergent aquatic vegetation (EAV), and Potamogeton sp. and Valisneria americana were used to represent submerged aquatic vegetation (SAV). Litter bags were maintained in an environmental chamber in the dark for 104 days. The fastest rate of total mass loss was in the SAV. V. americana and slowest in the EAV T. angustifolia. Changes in carotenoid and chloropigment concentration resulting from microbial and meiofaunal heterotrophy in each of the macrophytes were quantified using reverse-phase, high-performance liquid chromatography techniques. Plant pigment decay constants were determined

Chlorophyll c and carotenoid, fucoxanthin, prochiorophylic and carboning the constitution wided useful biomarkers in determining the presence of epiphytic diatom growth, which only occurred on the SAV. The highest concentrations of phaeophorbide a, commonly used as an indication of metazoan grazing, were found in the SAV V. americana. Low concentrations of phaeophorbide a in the SAV Potamogeton sp. indicate insufficient use of this SAV by meiofaunal grazers. Lutein use of this SAV of meioriannal grazers. Lutent decayed slower than all other carotenoids in both EAV and SAV. Additional studies that use con-trolled field and laboratory microcosm experi-ments are needed to further understand the biogeochemical cycling of photosynthetic pigments in natural environments. (Author's abstract)

# RESPONSES OF FISH AND MACROBENTHIC ASSEMBLAGES TO HYDROLOGICAL DISTURBANCES IN TIJUANA ESTUARY AND LOS PENASQUITOS LAGOON, CALIFORNIA.

San Diego State Univ., CA. Dept. of Biology. C. S. Nordy, and J. B. Zedler. Estuaries ESTUDO, Vol. 14, No. 1, p 80-93, March 1991. 14 fig, 6 tab, 28 ref. NOAA Grants NA86AA-D-CZO16, NA87AA-D-CZO29,

Descriptors: \*Benthic fauna, \*California, \*Environmental disturbances, \*Fish populations, \*Los Penasquitos Lagoon, \*Species composition, \*Tijuana Estuary, Runoff, Salinity, Spawning, Tidal flushing, Wastewater outfall, Wetlands.

To understand the responses to wider range and increased severity of stresses resulting from multiple disturbances, changes in the assemblages of shes and benthic macroinvertebrates were evaluated. ated in relation to wastewater inflows at Tijuana Estuary, in California, and impounded streamflows and mouth closure at Los Penasquitos Lagoon. Freshwater from sewage spills or winter rains low-ered water salinities and had major impacts on the channel organisms of both southern California coastal wetlands. Benthic infaunal assemblages responded more rapidly to reduced salinity than did fishes, with continued salinity reduction leading to the extirpation of most species. Both the fish and benthic invertebrate assemblages became dominated by species with early ages of maturity and protracted spawning seasons. Between-system comparisons showed that good tidal flushing reduced negative impacts on both the fish and benthic assemblages. (Author's abstract) W91-10178

# PLANNING AND LEGAL RESPONSES TO SEA-LEVEL RISE IN SOUTH AFRICA.

Cape Town Univ. (South Africa). Dept. of Environmental and Geographical Science.

M. R. Sowman, J. I. Glazewski, R. F. Fuggle, and A. H. Barbor.

South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 294-298, July/October 1990. 16 ref.

Descriptors: \*Coastal engineering, \*Coastal zone management, \*Future planning, \*Legal aspects, \*Policy making, \*Sea level rise, \*South Africa, Decision making, Economic aspects, Flooding, Groundwater movement, Inundation, Long-term planning, Regulations, Saline water intrusion, Shoreline erosion, Storms, Water table rise.

Coastal environments and communities are especially vulnerable to impacts resulting from sea-level rise, such as inundation and flooding of lowlying coastal land, increased shoreline erosion, increased frequency of and damage from storms, rising ground-water tables and salt-water intrusion into groundwater resources. In general, there are into groundwater resources. In general, there are three main categories of response that might be employed to offset potential impacts: engineering solutions, planning responses, policy and legal ini-tiatives, or a combination of these responses. Key planning and decision making authorities were interviewed to assess the level of awareness of planners and decision-makers to the anticipated rise in sea level, its impacts and implications; to identify what actions and planning measures are considered appropriate to address problems arising

from sea level rise; to determine who should take responsibility and who should bear the costs; and from these results assess the level of preparedness of planners and decision makers in the Cape to cope with these hazards. If the appropriate research effort is initiated in South Africa, particularsearch enter is minated in south Artica, particular-ly with regard to socioeconomic implications, and if governmental responsibilities for sea level issues are clearly delineated, the capacity to produce appropriate legal and policy initiatives, both miti-gatory and adaptive, will be enhanced. (Brunone-PTT) W91-10180

# COASTAL DUNES AS INDICATORS OF ENVI-RONMENTAL CHANGE,

Port Elizabeth Univ. (South Africa). Dept. of Ge-

South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 299-301, July/October 1990. 9 fig.

Descriptors: \*Coasts, \*Dunes, \*Environmental effects, \*Future planning, \*Geomorphology, Coastal zone, Geologic history, Indicators, Marine environment, Temporal distribution, Terrestrial environment, Wind intensity.

The many special characteristics of coastal dunes and coastal dune fields make them significant and sensitive indicators of changing conditions in the coastal zone. The coastal zone marks the transition of marine to terrestrial environments. Coastal dune systems are useful indicators of environmental con-ditions in the coastal zone mainly because dunes are 'soft landforms' which respond rapidly to the dynamic driving forces which make them. Coastal dunes can provide a data set which spans thou-sands to millions of years, which can enable the sands to minimos of years, which can enable the prediction of long-term trends. The dune systems adapt themselves to the stress field of the winds which are primarily responsible for forming them, and in doing so they record in their morphological shape and other relationships some of the distinctive features of the environmental driving forces. (Author's abstract) (Author's abstract) W91-10181

# EFFECT OF OCEANOGRAPHIC VARIABILITY ON SOUTH AFRICAN WEATHER AND CLIMATE.

Cape Town Univ. (South Africa). Dept. of Ocean-For primary bibliographic entry see Field 2B. W91-10184

# HISTORICAL CHANGES AND SEDIMENTARY CHARACTERISTICS OF SOUTHERN AF-RICAN ESTUARIES.

Port Elizabeth Univ. (South Africa). Inst. for Coastal Research.

J. S. V. Reddering, and I. C. Rust. South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 425-428, July/October 1990. 18 ref.

Descriptors: \*Climatic changes, \*Environmental quality trends, \*Estuarine environment, \*Estuarine sediments, \*History, \*South Africa, Environmental effects, Future planning, Global warming, River mouth, Sandbars, Sea level rise, Tidal flats.

Estuarine systems are sensitive to environmental change and an investigation into their responses could make a significant contribution to surveys on global change. Estuaries probably represent the most important direct link between marine and terrestrial environmental systems because the natural functioning of estuaries depends critically on contributions from both sea and land. Of the 289 South African river mouths, only 37 (12.8%) maintain permanent tidal inlets with the sea. The vast majority of river mouths have one of the following two forms: (1) for most of the time the mouth is blocked by a sand bar, and the river water has no free access to the sea, but terminates in a coastal area, or (2) the river discharges directly into the sea, without being affected by the tide. The majority of Southern African estuaries are small, their tidal prisms being 1,000,000 cubic m or less, and

# Field 2—WATER CYCLE

# **Group 2L—Estuaries**

most occupy drowned river valleys. These tidal inlets are usually constricted or, periodically, blocked by sand bars. Not all estuaries have well-developed tidal flats. Flood tidal deltas are common in Cape estuaries but mostly absent in Natal estuaries. Ebb-tidal deltas, which are poorly developed tidal flats, may be present. Estuaries along the Southern African coast would, in generalong the Southern African coast would, in general, benefit from a rise in sea level. However, the precise effects and impact of climatic change on these estuaries are difficult to visualize. Over the past 50 years the most dramatic changes in Southern African estuaries are recognized as being the result of human interference. Increased pressure from population growth has caused both local and regional modifications; this trend is expected to regular modulations, and the capetical escalate and, unless controlled future development takes place, unacceptable consequences for estuaries are guaranteed. (Brunone-PTT) W91-10188

GROWTH, REPRODUCTION AND RESOURCE

GROWTH, REPRODUCTION AND RESOURCE ALLOCATION IN HALOPHYTES. Toronto Univ. (Ontario). Dept. of Botany. R. L. Jefferies, and T. Rudmik. Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 3-16, February 1991. 6 fig, 33 ref.

Descriptors: \*Halophytes, \*Plant growth, \*Plant physiology, \*Reproduction, \*Salt tolerance, Aquatic habitats, Coasts, Genetics, Leaves, Salini-

Different patterns of growth and reproduction in halophytes are examined in relation to their ability to colonize saline habitats. In many halophytes, vegetative propagules are produced which estab-lish as ready-made plants, thereby bypassing the uncertainties of seedling establishment. In other species where agamospermy is well developed, genetic variation both within and between populations is limited. Halophytic species that have type of breeding system are extremely salt tolerant and an individual has the potential to give rise to a population of genetically uniform plants which are adapted to a narrow ecological niche. However, in a number of halophytes both genetic variation a number of naiophytes both genetic variation between populations and phenotypic plasticity of individuals occur as mixed strategies, enabling them to cope with environmental heterogeneity. The value of integrating studies of genetic variation in populations with molecular, biochemical and ecological studies is evident, and such an integrated assessed assessed to be directly assistant. and ecological studies is evident, and such an inte-grated approach appears to be directly applicable to studies of salt tolerance in plant populations. Phenotypic plasticity in response to a changing environment is likely to be well developed in long-lived perennial halophytes. Conditions at the time of establishment may be very different from those one or two decades later. Leaf plasticity was exam-ined in plants of Triglochin maritima grown at different salinities. A reduction in both number and size of leaves per shoot, and changes in the nutrient and water contents of leaves, occurred as the salinand water contents of leaves, occurred as the salinity increased. Acclimation to increased salinity took at least 50 days before the relative birth rate of leaves per shoot of plants in the different saline cultures was similar. (Author's abstract)

GROWTH, WATER AND ION RELATION-SHIPS OF HALOPHYTIC MONOCOTYLE-DONAE AND DICOTYLEDONAE: A UNIFIED CONCEPT.

Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.

Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 17-33, February 1991. 2 fig, 2 tab, 59 ref.

Descriptors: \*Halophytes, \*Plant growth, \*Plant physiology, \*Saline water, \*Water stress, Angio-sperms, Dicotyledons, Evolution, Model studies, Monocotyledons, Potassium, Sodium.

Halophytic angiosperms seem to have secondarily ratiophytic angiosperms seem to have secondarily acquired adaptations to saline terrestrial environments, and have lost the salt requirement of enzymes and membranes that is primarily present in aquatic marine bacteria, algae, and fungi. Halophytic monocotyledonae differ in some respects from

salt-adapted dicotyledonae. Their growth rate is not stimulated by salt and is often lower than in dicotyledonae at increased salinity; they have a markedly lower internal Na:K ratio and a lower water content. Also, diurnal variation of leaf extension and leaf thickness differs significantly between monocotyledonae and dicotyledonae. This is related to the position of the growth meristem of expanding leaves. Monocotyledonous halophytes seem to be more efficient in the use of water than dicotyledons. The correlation that exists between values of the mean relative growth rate measured under saline conditions and leaf elongation and leaf thickness variation indicates that water stress rather than ion (toxicity) stress is the cause of growth reduction at increased salinity under these circumstances. A qualitative model is presented focusing on the different position and exposition of the growth meristem in monocotyledonae and di-cotyledonae, which aims to provide a physiologi-cal and morphological explanation of the different growth, water and mineral economy of monocoty-ledonous and dicotyledonous halophytes. (Author's abstract) W91-10194

EFFECT OF ELEVATED ATMOSPHERIC CO2 ON GROWTH, PHOTOSYNTHESIS AND WATER RELATIONS OF SALT MARSH GRASS SPECIES.

Vrije Univ, Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology. For primary bibliographic entry see Field 5C. W91-10195

EFFECT OF SHORE POSITION AND ENVIRONMENTAL METAL LEVELS ON BODY METAL BURDENS IN THE BARNACLE, ELMINIUS MODESTUS.

Manchester Univ. (England). Dept. of Environment Brief.

mental Biology.
For primary bibliographic entry see Field 5B. W91-10203

BENTHIC POPULATION STUDIES OF A NORTH SEA DISPOSAL AREA USED FOR IN-DUSTRIAL LIQUID WASTE.

Imperial Chemical Industries Ltd., Brixham (England). Group Environment Lab. For primary bibliographic entry see Field 5C. W91-10206

DISTRIBUTION OF SELECTED HEAVY METALS IN SKIN AND MUSCLE OF FIVE TROPICAL MARINE FISHES.

University of the West Indies, St. Augustine (Trinidad and Tobago). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-10208

EFFECT OF TEMPERATURE AND SIZE ON DEVELOPMENT, MORTALITY, AND SURVIV-AL RATES OF THE PELAGIC EARLY LIFE HISTORY STAGES OF MARINE FISH.

Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 503-518, March 1991. 12 fig, 8 tab, 135 ref.

Descriptors: \*Fish, \*Larval growth stage, \*Life history studies, \*Marine environment, Aquatic habitats, Literature review, Mortality, Survival, Water temperature.

A comprehensive review is presented of develop-ment, mortality, and survival rates of fish eggs, yolk-sac larvae, and postlarvae in relation to tem-perature and size. The general temperature-de-pendent and, where applicable, size-dependent models explained 30-81% of the variance in vital moutes explained 30-61% of the variance in vital rates. Daily development and mortality rates gen-erally increased with increasing temperature. Tem-perature had an equal but opposite effect on stage-specific cumulative mortality rates of eggs and yolk-sac larvae. Stage-specific (length-dependent) cumulative mortality rates of postlarval fish were

independent of temperature due to equal effects of temperature on daily growth and daily mortality rates. Size had no significant effect on daily or cumulative mortality rates of eggs and yolk-sac stages. Daily mortality rates of postlarval fish were significantly influenced by mean size (i.e. length). The compensation of temperature effects between stages and/or vital rates may reduce the impact of environmental uncertainty on survival rates. The general temperature-dependent and/or size-dependent relationships described may serve as basic frameworks to assess whether there are significant effects resulting from species/stock-specific characteristics or environmental factors on the vital rates of the early life history stages of fish. (Au-'s abstract) W91-10221

REMOTE SENSING OF MARINE PHOTOSYN-THESIS.

Division of Fisheries, CSIRO Marine Laboratories, GPO Box 1538, Hobart 7000, Tasmania, Australia.

For primary bibliographic entry see Field 7B. W91-10386

# 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

# 3A. Saline Water Conversion

PHYSICOCHEMICAL AND HYDRODYNAMIC EFFECTS ON COLLOIDAL FOULING REDUCTION IN REVERSE OSMOSIS.

Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering

Mechanical Engineering.
P. C. Renaud, and R. F. Probstein.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-162859.
Price codes: A03 in paper copy; A01 in microfiche.
Final Report, February 1991. 20p, 10 fig, 1 tab, 6
ref. USGS Contract No. 14-08-0001-G1289.

Descriptors: \*Reverse osmosis, \*Fouling, \*Membrane fouling, \*Colloidal fouling, \*Flux decline, \*Turbulent flow, \*Laminar flow, Foulant growth, Permeation velocity, Transmembrane flux, Ferric hydroxide fouling, Cellulose acetate membranes.

An experimental study was carried out on colloidal folling by iron hydroxide of reverse osmosis mem-branes using tubular asymmetric cellulose acetate membranes. The study sought to determine wheth-er there exists in turbulent flow a threshold transmembrane (permeation) velocity below which no colloidal fouling takes place. Experiment established and a simple model confirmed that under stable colloid conditions, where the colloid does not floc or aggregate, that there does exist a threshold velocity in turbulent flow whose value is about the same as in laminar flow. Under unstable conditions, where electrolytes are present, a threshold velocity still exists but its value is greatly reduced. The threshold velocity phenomenon can be used in practice to reduce or eliminate colloid fouling for stable solutions, although it is not useful where electrolytes are present, as in seawater. Importantly it is found that there is no advantage to employing turbulent flow to reduce fouling when operating at threshold conditions, as the threshold velocity value was found to be independent of the axial flow Reynolds number up to a value of 26,300. (USGS) W91-09860

### 3B. Water Yield Improvement

CATCHMENT BASIN WATER HARVESTING AS A MEANS OF IMPROVING THE PRODUC-TIVITY OF RAIN-FED LAND IN UPLAND BA-LOCHISTAN.

Arid Zone Research Inst., Quetta (Pakistan).
D. J. Rees, Z. A. Qureshi, S. Mehmood, and S. H.

Journal of Agricultural Science JASIAB, Vol. 116,

### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

# Use Of Water Of Impaired Quality—Group 3C

No. 1, p 95-103, February 1991. 5 fig, 6 tab, 13 ref.

Descriptors: \*Agricultural water, \*Catchment basins, \*Cropland, \*Pakistan, \*Water harvesting. Cost analysis, Crop yield, Rainfall, Water storage, Waterlogging, Yermosols.

A method of harvesting catchment basin water is aimed at improving productivity and yield stability on rain-fed land in valley bottoms in Balochistan, Pakistan, where the traditional forms of water harvesting are not used. The field tests were conducted in farmers' bunded fields (bound with earth banks to demarcate ownership and catch any within-field runoff) on gently sloping valley bottom soils classified as yermosols. Catchment basins were prepared within bunded fields by smoothing and compacting the soil. The ratio of catchment area to cropped area was 1:1 or 2:1. In the 1:1 treatment the upper 50% of the area was compacted to form a catchment basin, while in the 2:1 treatment f5% of the area was formed into a Pakistan, where the traditional forms of water har-2:1 treatment 67% of the area was formed into a catchment basin. In the control field, the entire area was cropped. Annual rainfall varied from 102 to 282 mm. Runoff from the catchment basins area was cropped. Annual rainal value in 10th 10z 282 mm. Runoff from the catchment basins increased water storage in the cropped areas by 55 and 43% of the rain falling on the catchments in the 1:1 and 2:1 treatments, respectively. Water harvesting resulted in considerably increased yields in the cropped area, but not always sufficiently enough to compensate for the loss of cropped land. Average yields from the 1:1 treatment were 95% of the control yields. Yields in the 2:1 treatments were reduced by waterlogging damage. The cost of catchment set-up was low compared with the reduced seed and plowing costs in the water-harvesting treatments, resulting in 18 and 31% reductions in overall costs for the 1:1 and 2:1 treatments, respectively. Net benefits for the 1:1 treatment equalled or exceeded those of the control, but were 32% lower for the 2:1 treatment. Within-field 32% lower for the 2:1 treatment. Within-field water harvesting with a 1:1 crop-catchment ratio water narvesting with a 1:1 crop-attenue had reduced risk by reducing investments in seed and animal draft power, while maintaining yields and net benefits indicating that this could be of considerable benefit to the farmers. (Medina-PTT) W01\_00038

PHILOSOPHICAL AND CULTURAL CON-CEPTS UNDERLYING WATER SUPPLY IN

Newcastle Univ. (Australia). Dept. of Classics. For primary bibliographic entry see Field 5F. W91-10107

# 3C. Use Of Water Of Impaired **Ouality**

SALINITY, NITRATE AND WATER IN RANGELAND AND TERRACED WHEATLAND ABOVE SALINE SEEPS.

Southern Plains Range Research Station, Woodward, OK.

For primary bibliographic entry see Field 4C. W91-09328

GROUNDWATER QUALITY.
Nebraska Univ. Lincoln

Nebraska Univ., Lincoln. Dept. of Agronomy. For primary bibliographic entry see Field 4C. W91-09329

LANDFILL LEACHATE RECIRCULATION: EFFECTS ON VEGETATION VIGOR AND CLAY SURFACE COVER INFILTRATION. Guelph Univ. (Ontario). Dept. of Land Resource

P. M. Cureton, P. H. Groenevelt, and R. A. McBride.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 17-24, January/March 1991. 2 fig, 7 tab, 30 ref. Ontario Ministry of the Environment Project 333G.

Descriptors: \*Landfills, \*Leachates, \*Vegetation, \*Wastewater disposal, \*Wastewater irrigation, \*Wastewater utilization, Environmental effects, Grasses, Hydraulic conductivity, Landfill covers,

Lysimeters, Ontario, Osmoreg growth, Poplar trees, Willow trees. Osmoregulation, Plant

Continuous recirculation of two municipal solid waste (MSW) landfill leachates from Ontario, Canada, through a vegetated clay surface cover was field tested in 39 bottom-draining lysimeters over two field seasons. The more concentrated of over two field seasons. The more concentrated of the leachates had an osmotic potential of about - IkJ/kg, an electrical conductivity of 0.8 to 1.0 S/m, a chemical oxygen demand of 9.9 to 18.7 g/kg, and a pH of 6.5 to 7.0. Vegetation tested included reed canarygrass, meadow foxtail, weeping willow and hybrid poplar. Leachate recirculation stimulated growth height by 36 to 141% in the four species relative to water irrigated control plants. After a total leachate application of 740 mm over two seasons, hybrid poplar and weeping willow showed signs of chlorosis, widespread necrosis, and leaf desiccation. In the hybrid poplar, early leaf senescence, and reductions in photosynthesis, stomatal conductance, and transpiration rates were stomatal conductance, and transpiration rates were also observed. Vegetative stress was most likely a also observed. Vegetative stress was most likely a result of cosmoregulation disruption arising from depressed soil solution osmotic potential. In the reed canarygrass swards, total evapotranspiration over the second season was increased by over 50%, height growth by 87%, and foliar biomass production by 160%. No phytotoxic symptoms or receptive the second season was also constituted to the control of the co excessive trace metal accumulations were ob-served, thus reed canarygrass shows good potential serven, must react animy grass shows good potential as a cover vegetation species for leachate recirculation sites under northern temperate climatic conditions. The field saturated hydraulic conductivity of the silty clay surface covers irrigated with landfill leachate, measured to be in the order of 0.00005 m/s, was significantly higher than that measured in m/s, was significantly higher than that measured in the water irrigated control surface covers. No evidence existed of soil pore clogging with particulates. Volumetric shrinkage of the clay-rich soil cover was thought to be due to physicochemical incompatibility with applied leachates containing salts and organic solvents. (Doyle-PTT) W91-09330

SALINITY AND BORON TOLERANCES OF CANDIDATE PLANTS FOR THE REMOVAL OF SELENIUM FROM SOILS. California Univ., Riverside. Dept. of Soil and En-

vironmental Scien For primary bibliographic entry see Field 5G. W91-09343

IS REMEDIATED GROUNDWATER MEETING

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div. For primary bibliographic entry see Field 5F. W91-09404

INTERACTION OF SALINITY AND TEMPERATURE ON THE GERMINATION OF CRAMBE.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
J. L. Fowler.

Agronomy Journal AGJOAT, Vol. 83, No. 1, p 169-172, January/February 1991. 3 fig, 2 tab, 21

Descriptors: \*Arid lands, \*Crambe, \*Germination, \*Irrigation water, \*Oilseed crops, \*Saline water, \*Semiarid lands, \*Soil-water-plant relationships, Electrical conductivity, Saline soils, Salinity stress, Temperature effects.

Crambe (Crambe abyssinica) is a potential oilseed crop for semiarid and arid environments where saline irrigation waters and soils are common. Crambe tolerance to salinity during germination is unknown. A laboratory experiment was designed to determine salinity tolerance of crambe during germination and salinity x tolerance interactions that may influence termination and stand establishment. Treatment solutions were prepared using NaCl and CaCl(2) in a 2:1 molar ratio. Salinity (electrical conductivities (dS/m) of 0.03, 6.3, 12.1, 17.3, 22.5, 27.1, 32.0 and 36.3 dS/m) and temperature (5, 10, 15, 20 and 30 C) effects on germination of cultivar Meyer crambe seed were determined

over a 12 d period. Counts were taken at 3 d intervals and germination percentages and rate in-dexes were determined. Germination declined with increasing salinity at each counting date and salinity at temperature interactions were significant. Germination was severely limited at 5 C with only 22% germination in the salinity control (0.03 dS/m) after 12 d. The optimum germination temperature for all salinity levels fell in the 15 to 25 C range, with the final cumulative germination percentage peaking at 20 C for most treatments. Germination decreased on either side (10 and 30 C) of the optimum. Germination rate was drastically reduced at 5 C at all salinity levels, with an intermediate effect at 10 and 30 C at the lower salinity levels decreasing with increasing salinity at all temperatures. These results suggest that crambe is moderately tolerant to salinity stress during germination over the 10 to 30 C temperature range. (Author's abstract) increasing salinity at each counting date and salini-W91-09912

APPLICATION OF DISTILLERY WASTE AN-AEROBIC DIGESTER EFFLUENT TO ST. AU-

Southeast Kansas Branch Experiment Station, Par-

For primary bibliographic entry see Field 5E.

TOMATO FRUIT YIELDS AND QUALITY UNDER WATER DEFICIT AND SALINITY. California Univ., Davis. Dept. of Vegetable Crops. J. P. Mitchell, C. Shennan, S. R. Grattan, and D.

Journal of the American Society for Horticultural Science JOSHB5, Vol. 116, No. 2, p 215-221, 1991. 6 fig, 6 tab, 21 ref.

Descriptors: \*Crop yield, \*Deficit irrigation, \*Impaired water use, \*Irrigation effects, \*Salinity, \*Tomatoes, \*Water deficit, Drainage water irrigation, Irrigation, Saline soils, Salt tolerance,

The effects of deficit irrigation and irrigation with aline drainage water on processing tomato yields, fruit quality, and fruit tissue constituents were investigated in two field experiments. Deficit irrigation reduced fruit water accumulation and fresh fruit yield, but increased fruit soluble solids level and led to higher concentrations of hexoses, citric acid, and potassium. Irrigation with saline water had no effect on total fresh fruit yield or hexose concentration, but slightly reduced fruit water content, which contributed to increased inorganic content, which contributes to inferease inforganic ion concentrations. Fruit set and marketable solu-ble solids (marketable red fruit yield x percent soluble solids) were generally unaffected by either irrigation practice. Water deficit and salinity insed starch concentration during early fruit development, but, at maturity, concentrations were reduced to <1%, regardless of treatment. Higher fruit acid concentrations resulted from water deficit irrigation and from irrigation with saline water relative to the control in one year out of two. These results support the contention that deficit irrigation and irrigation with saline drainage water irrigation and irrigation with saline drainage water may be feasible crop water management options for producing high quality field-grown processing tomatoes without major yield reductions. Appropriate long-term strategies are needed to deal with the potential hazards of periodic increases in soil salinity associated with use of saline drainage water for irrigation. (Author's abstract)

WATER QUALITY EFFECTS ON SOILS AND ALFALFA: I, WATER USE, YIELD, AND NUTRIENT CONCENTRATION.

North Dakota State Univ., Fargo. Dept. of Soil

L. Prunty, B. R. Montgomery, and M. D. Sweeny. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 196-202, January/February 1991. 4 fig, 6 tab, 20 ref. U.S. Dept. of Interior, Contract no. 9-07-60-V0025.

Descriptors: \*Alfalfa, \*Crop yield, \*Impaired water quality, \*Irrigation effects, \*Nutrient con-

# Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

# Group 3C—Use Of Water Of Impaired Quality

centrations, \*Plant growth, \*Water use, Great Plains, Irrigation water, Loam, Salinity, Sodium adsorption ratio, Soil types.

The detrimental effects of salt buildup in northern Great Plains soils needs quantification. The effects Great Plains sous needs quantification. The effects of irrigation water quality on alfalfa yield, water use, and nutrient concentration during a 21-mo period were investigated. Irrigation waters of 7 qualities, totalling 4400 mm in wet/dry cycles, were applied to 20 by 60 cm undisturbed soil columns under greenhouse conditions. Four loam soils representing moderate to moderately slow permeable drainage classes were used. The soils were: Williams loam (fine-loamy, mixed Typic Ar-giboroll), Barnes loam (fine-loamy, mixed Udic Haploboroll), Svea loam (fine-loamy, mixed Pachic Haploboroil), svea loam (the-loamy, musce Facinic Haploboroil), and Parshall loam (coarse-loamy, mixed Pachic Haploboroll). Effects of soil, water quality, and time on yield and water use were highly significant. In all soils and waters, yield and water use decreased 30-60% by the end of the experiment. Mean nutrient concentrations, with the experiment. Mean nutrent concentrations, with the exception of Na, remained within 10% of the original values. Irrigation water with sodium adsorption ratio of 20 and ionic concentration of 20 mmol/L increased the alfalfa Na concentration to 15 times that with distilled irrigation water. Total Na added accounted for 84% of variation in relative yield. One-half of the salt-induced yield reduction appeared in the first third of the experiment. This underscores the inadvisability of irrigating with poor-quality water that might be available during drought periods. (See also W91-09971) (Author's abstract) W91-09970

WATER QUALITY EFFECTS ON SOILS AND ALFALFA: II. SOIL PHYSICAL AND CHEMI-CAL PROPERTIES.

North Dakota State Univ., Fargo. Dept. of Soil

Science.
J. L. Costa, L. Prunty, B. R. Montgomery, J. L.
Richardson, and R. S. Alessi.
Soil Science Society of America Journal SSSJD4,
Vol. 55, No. 1, p. 203-209, January/February 1991.
3 fig., 6 tab, 32 ref. U.S. Dept. of Interior, Contract
no. 9-07-60-V0025.

Descriptors: \*Alfalfa, \*Impaired water quality, \*Irrigation effects, \*Irrigation water, \*Salinity, \*Soil chemistry, \*Soil physical properties, \*Soil water, Calcium, Conductivity, Density, Dispersion, Great Plains, Loam, Sodium adsorption ratio, Soil securical Soil of the Plains of

Soil saturation, Soil types.

Salt accumulation can occur in northern Great Plains soils during irrigation with saline water. This study investigated the effects of salinization produced in Barnes loam (fine-loamy, mixed Udic Haploboroll), Parshall loam (coarse-loamy, mixed Pachic Haploboroll), Svea loam (fine-loamy, mixed Pachic Haploboroll), and Williams loam (fineloamy, mixed Typic Argiboroll) soils by irrigation with 7 water qualities during 21 mo of greenhouse alfalfa production in undisturbed columns. Eight physical and chemical soil properties were evaluated and related to soil, water quality, and depth in the soil. Saturation percentage (SP) of the soil increased 0.2% for each unit increase in soil-ex-tract sodium adsorption ratio (SAR-e). Saturation extract electrical conductivity (EC-e) increased with depth, at rates dependent on water quality, to maximums of 1-17 ds/m. Parshall soil was most maximums of 1-17 ds/m. Parshall soil was most susceptible to dispersion as SAR-e increased. From the surface to 15-cm depth, bulk density was reduced 0.04 to 0.06 Mg/cu m by the water that resulted in the highest soluble-Ca concentration. Significant regression models were developed for SP, EC-e, SAR-e, and salt precipitation. Parshall, the most irrigable soil, was the most detrimentally affected, as judged by dispersion, EC-e, and SAR-eight surface a need for further investigation. e, indicating a need for further investigation.

Barnes, Svea, and Williams soils proved more suited to irrigation than previously believed. (See also W91-09970) (Author's abstract) W91-09971

ADSORPTION OF COPPER BY CERTAIN SOIL TYPES OF THE UKRAINE,
For primary bibliographic entry see Field 2G.

W91-10015

LONG-TERM EFFECTS OF SEWAGE SLUDGE AND FARM SLURRIES APPLICATIONS. For primary bibliographic entry see Field 5E W91-10270

USE OF DIGESTED EFFLUENTS IN AGRICULTURE.

ULITURE.

Universite Catholique de Louvain, Louvain-laNeuve (Belgium).

M. Demuynck, E. J. Nyns, and H. Navevau.

In: Long-Term Effects of Sewage Sludge and
Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 2-13, 1 fig, 1 tab,

Descriptors: \*Agriculture, \*Fertilizers, \*Land disposal, \*Wastewater farming, Anaerobic digestion, Carbon, Corn, Effluents, Grain crops, Methane, Nitrogen, Nutrients, Organic matter, Rye

Although anaerobic digestion has no effect on the quantity of the waste treated, it does have an effect quantity of the waste treated, it does now an electron on its quality and consequently, on its fertilizer value. Thirty to forty percent of the organic matter of digested waste, which can be either manure or sludge, is transformed into methane; the remaining organic matter is more stable. If the total nitrogen organic matter is more stable. If the total nitrogen content of the waste remains the same, the proportion of ammonia-nitrogen increases (10-70% increases have been reported) and the proportion of organic nitrogen decreases. The disinfecting effect of the anaerobic digestion process is only partial, allowing for the destruction of some of the pathogens (bacteria, viruses) under normal running operations. The directed water is only free of pathogens (bacteria, viruses) under normal running operations. The directed water is only free of pathogens and the property of the control of the directed water is only free of pathogens. gens (oacteria, vintses) intuer normal running operations. The digested waste is only free of pathogens after treatment under thermophilic conditions. When digested effluent is spread on land, the effect of biomethanation treatment is positive because the waste is deodorized, liquified, homogenized and less sticky. Therefore, the waste disap-pears more quickly into the soil avoiding the suppears indee ducky into the soft avoiding the sup-pression of the vegetation, and hindering the weeds from coming out. Since the dispersion of nitrogen from the digested effluents is higher than for effluents which are raw or stabilized using for effluents which are raw or stabilized using other methods, yields of crops with high nitrogen demands will be improved. Rye grass and corn are typical examples. With a lowering of the C:N ratio of the digested effluent, the depressive effect which occurs normally after the application of sewage sludges can be avoided. (See also W91-10270) (Author's abstract) 91-10271

EXPERIMENTS ON THE FERTILISER VALUE OF ANIMAL WASTE SLURRIES.
Ministry of Agriculture, Wolverhampton (Eng-

land). For primary bibliographic entry see Field 5E.

W91-10281

EVALUATION OF URBAN AND ANIMAL WASTES AS SOURCES OF PHOSPHORUS. Institut National de la Recherche Agronomique, Station d'Agronomie, 33140 Pont de la Maye,

B. Pommel

In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 210-215, 3 fig, 2

Descriptors: \*Animal wastes, \*Nutrients, \*Phosphorus, \*Sludge disposal, \*Sludge utilization, Chemical industry, Composting, Fertilizers, Industrial wastes, Municipal wastes, Plant growth.

Organic wastes as a whole, whether coming from agriculture, towns, or the food industry, constitute a considerable reserve of phosphorus, the fertiliz-ing value of which needs to be determined. In order to appreciate the specific value of wastes and take into account the effects of different possible treatments, a biological test was perfected in which P uptake by a plant could be measured along time, depending only on P supply without any interac-tion with soil and climate. Under sand cultivation conditions, slags (s) were found to be a good P fertilizer, the P of which is 80-90% as efficient as monocalcium phosphate-P. Sludges composted with sawdust (cos) had a lower P content than digested sludges, but a higher P availability than slags. Chemical sludges (chs) had a higher P content than digested sludges with a higher P availability; they are likely to constitute a future source of P. In the very short-term digested sludges are a of P. In the very short-term, digested sludges are a poor P fertilizer. After 3 weeks of root-P source contact, their P is 20-35% efficient; this increases, contact, their P is 20-35% efficient; this increases, with time, up to 60%. Therefore, digested sludges have to be regarded as a slow release phosphatic fertilizer. Liming of digested sludges does not significantly affect the availability of its P in the standard conditions of the experiment. Finally, garbage compost produced an extremely poor level of P nutrition. (See also W91-10270) (Lantz-PTT) W91-10289 W91-10289

### 3D. Conservation In Domestic and Municipal Use

ESTIMATION OF GROUNDWATER PROTEC-TION BENEFITS AND THEIR UTILIZATION BY LOCAL GOVERNMENT DECISION DECISION-MAKERS.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6B. W91-09825

# 3E. Conservation In Industry

STATE OF WATER ENVIRONMENT IN HUN-GARY.

Vizgazdalkodasi Tudomanyos Kutato Intezet, Bu-

dapest (Hungary).
For primary bibliographic entry see Field 5G. W91-09378

### 3F. Conservation In Agriculture

INFLUENCE OF FERTILIZER, IRRIGATION, AND NON-GROWING SEASON PRECIPITA-TION ON SOIL NITRATE-NITROGEN UNDER

Macdonald Coll., Ste. Anne de Bellevue (Quebec).
Dept. of Renewable Resources.
B. C. Liang, M. Remillard, and A. F. MacKenzie.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 123-128, January/March 1991. 6 fig, 6 tab, 30 ref.

Descriptors: \*Agricultural practices, \*Corn, \*Fertilizers, \*Nitrates, \*Soil water, \*Water pollution sources, Denitrification, Farm management, Irrigation, Leaching, Mineralization, Nutrients, Path of pollutants, Quebec, Seasonal variation, Soil amendments, Soil chemistry.

Corn (Zea mays) production requires large amounts of N fertilizer, which may be lost due to leaching of denitrification. Prediction of the amount lost would be helpful in minimizing these losses. A field experiment was conducted to inves-tigate the effects of fertilization, irrigation, and tigate the effects of fertilization, irrigation, and non-growing season precipitation on soil NO3-N under corn in southwestern Quebec, from 1984 to 1987. The high rate of fertilization (400 kg N/ha, 100 kg P2O5/ha, 170 kg K2O/ha) over the normal rate (170 kg N/ha, 100 P2O5/ha, 170 kg K2O/ha) significantly increased soil NO3-N during the growing season, and a residual effect of fertilizer rate on soil NO3-N levels was noted in 2 of 3 yr during the nongrowing season. The high rate of fertilization, did not increase NO3-N accumulation in the soil profile over the normal rate of fertilization in successive vears. Irrigation signififertilization in successive years. Irrigation signifi-cantly decreased soil NO3-N during the growing season. At the normal rate of fertilization, gains of soil NO3-N over winter were found with lower winter precipitation. At the high rate of fertiliza-tion, however, losses of soil NO3-N over winter occurred in 2 of the 3 yr. The changes in NO3-N in the rooting zone over winter depended upon the

### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

# Conservation In Agriculture—Group 3F

precipitation received during the preceding winter and the amount of NO3-N in the soil the previous fall. (Author's abstract)

ACCUMULATION AND INTERACTIONS OF ARSENIC, SELENIUM, MOLYBDENUM AND PHOSPHORUS IN ALFALFA.

California Univ., Riverside. Dept. of Soil and Environmental Sciences. For primary bibliographic entry see Field 5B. W91-09344

# PROBLEMS AND POTENTIAL OF IRRIGATED AGRICULTURE IN SUB-SAHARAN AFRICA. M. Alam. Lournal of Agriculture and Agr

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 155-172, March/April 1991. 1 fig, 5 tab, 14 ref.

Descriptors: \*Agriculture, \*Economic aspects, \*Irrigation projects, \*Sub-Saharan Africa, \*Water resources development, \*Water resources management, Groundwater irrigation, Irrigation operation, Pilot projects, Public investment, Social as-

Examination of 15 World Bank-funded irrigation projects in sub-Saharan Africa revealed no specific pattern of project performance or cost of development of irrigated agriculture in the area. Some of the projects have been successful while others the projects have been successful while others have had questionable economic and social impact. The cost per hectare of irrigated agricultural development in sub-Saharan Africa varies widely. The success or failure of irrigation development in the region appears to be due to good or poor management from planning through operation and maintenance. With careful planning and management of the project, cost of irrigated agriculture development could be comparable to other parts of the world. In most sub-Saharan African countries, maior emphasis has been placed on large-scale major emphasis has been placed on large-scale modern irrigation schemes. These countries must choose the right balance between large-scale pubchoose the right balance between large-scale publicly managed schemes and small-scale privately managed irrigation systems. Priority should be given to development of small-scale private sector irrigation development and improvement and modernization of traditional irrigation systems. Rehabilitation of existing projects should also receive priority. Potential of large-scale irrigation development in selected areas should be explored and examined carefully. In general, the potential of large-scale development has been overestimated because of the scarcity of information upon which the projects are planned. In sub-Saharan Africa, the potential of groundwater irrigation has not yet the potential of groundwater irrigation has not yet been fully explored. Pilot projects in groundwater irrigation should be conducted in selected areas to inigation should be conducted in selected areas to test the economical and technical viability of groundwater irrigation in sub-Saharan Africa. (Author's abstract)
W91-09391

# SENSITIVITY OF FURROW IRRIGATION SYSTEM COST AND DESIGN VARIABLES. Wyoming Univ., Laramie. Dept. of Agricultural

Engineering.

Engineering.
J. M. Reddy, and H. M. Apolayo.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 117, No. 2, p 201-219,
March/April 1991. 6 fig, 9 tab, 10 ref, append.

Descriptors: \*Design criteria, \*Economic aspects, \*Estimated costs, \*Furrow irrigation, \*Irrigation design, Clays, Drainage systems, Flow rates, Irrigation, Irrigation management, Mathematical equations, Percolation, Sand, Seasonal distribution, Soil properties, Soil texture, Soil types.

Considering the minimum cost as the objective, the furrow irrigation system design problem is formulated as an optimization problem. A combination of monotonicity analysis, constraint activity, and con-densation are used to simplify the size of the mathematical model of the problem. This reduced model is used to analyze the sensitivity of the optimal design variables of a furrow irrigation

system. The Soil Conservation Service equations for the design of furrow irrigation along with several constraints are considered in the optimal several constraints are considered in the optimal design. Using an example problem and three different soil types, the system cost and design variables (inflow rate, length of furrow, and time of cutoff) are found to be sensitive to the supply flow rate, the design application depth, and the cost coefficients of water, labor, and ditch construction. Since the number of irrigations required per season decreases as the design depth increases, the seasonal cost of the system decreased with an increase in the design depth, independent of the soil type. Under the given set of conditions, the cost of a furrow irrigation system is shown to be very high for a clay soil. The application efficiency achieved for a clay soil. The application efficiency achieved was lower for clay soils than for light (sandy) and medium textured soils. The medium-textured soil heating textures soils. The medium-textured soil had the least cost design for all the design depths considered in the analysis, due to the deep percolation and runoff losses, respectively, for the sandy and clay soils. (Brunone-PTT) W91-09394

# SIMULATION OF WIND-DISTORTED SPRIN-KLER PATTERNS.

Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 7C. W91-09399

# GRAIN YIELD, STALK ROT, AND MINERAL CONCENTRATION OF FERTIGATED CORN AS INFLUENCED BY N P K.

Illinois Univ., Urbana. Dept. of Agronomy. D. G. Bullock, G. J. Gascho, and D. R. Sum Journal of Plant Nutrition JPNUDS, Vol. 13, No. 8, p 915-937, 1990. 2 tab, 20 ref.

Descriptors: "Agriculture, "Corn, "Crop yield, 
"Fertilizers, "Georgia, "Groundwater quality, "Irrigation, "Nitrogen, "Nutrient concentrations,
"Nutrient requirements, "Phosphorus, "Potassium,
Economic aspects, Fertigation, Leaching, Limiting
nutrients, Loamy sand, Nitrates, Plant growth,
Trace minerals.

Increasing fertilizer costs, decreasing grain prices, Increasing fertilizer costs, decreasing grain prices, and groundwater quality concerns, have sparked considerable interest in a management option where for one year, fertilizer rates of irrigated corn, in a corn/peanut rotation, are reduced below the current recommendation. Fertilizer comprises approximately 50% of the variable production costs of irrigated corn. Reduction of fertilizer inputs, in particular nitrogen may reduce activities. inputs, in particular nitrogen, may reduce variable costs and decrease nitrate leaching to groundwater, but yields may also suffer. The effect of nitrogen, phosphorus, and potassium fertilizer rates on the yield of nitrogen-fertigated corn was tested in a corn/peanut rotation. Field experiments were con-ducted during 1987 and 1988 on a Tifton loamy sand at Tifton, Georgia. Treatments were three rates each of nitrogen, phosphorus, and potassium in a complete factorial experimental design. Nitrogen, phosphorus, and potassium rates were 168, 252, 336 kg N/ha/year; 44, 73, 103 kg P/ha/year; and 84, 223, and 363 kg K/ha/ year. Grain yields were large, 12.6 and 10.4 Mg/ha in 1987 and 1988, respectively, but not affected by nitrogen, phosphorus, or potassium rates. Since the lowest rates phorus, or potassium rates. Since the lowest rates of nitrogen, phosphorus, and potassium were less than recommended, fertilizer use efficiency for fer-tigated corn can be improved, for at least one year, by reducing nitrogen, phosphorus, and potassium fertilizer rates to less than current recommendations. Rates of nitrogen, phosphorus and potassium did not result in a substantial difference in the concentration of essential nutrients. Stalk rot was limited (<15%), but decreased with increasing potassium fertilizer rate. (Brunone-PTT) W91-09400

# INFLUENCE OF TEMPORARY FLOODING AT THREE GROWTH STAGES ON SOYBEANS GROWN ON A CLAYEY SOIL.

Arkansas Univ., Fayetteville. Dept. of Agronomy. For primary bibliographic entry see Field 21. W91-09401

# EFFICIENT SPATIAL ALLOCATION OF IRRIGATION WATER. Hawaii Agricultural Experiment Station, Honolu-

U. Chakravorty, and J. Roumasset.

American Journal of Agricultural Economics AJAEBA, Vol. 73, No. 1, p 165-173, February 1991. 3 fig, 1 tab, 18 ref.

Descriptors: \*Economic aspects, \*Irrigation efficiency, \*Irrigation water, \*Model studies, \*Pricing, \*Taxes, \*Water allocation, \*Water conveyance, \*Water loss, Administration, Benefits, Irrigation, Benefits, Irrigation and Benefits, Beneries, Benefits, Benefits, Benefits, Benefits, Benefits, Benefit tion, Marginal costs, Optimization, Water policy,

A theoretical model was developed that derives rules for optimal allocation of water supplied to farmers at various distances from a water source. In the presence of conveyance losses, the efficient quantity of water applied falls with distance from the water source, but the amount of water sent (including conveyance losses) actually increases with distance from the source, except toward the tail end of the irrigation system. Water allocations are maximized at about 25 km from the source. This implies that if marginal cost pricing were implemented, farmers at the middle and lower reaches of the system would have to pay more money for less water received. If farm size is uniform, total water charges under marginal cost pricing are maximized at the point of maximum source water and do not vary substantially over space. Thus, schemes that charge spatially uniform taxes but ration efficient water allocations might be an attractive policy option. When compared to other taxation schemes, marginal cost pricing is most inequitable, while proportional benefit tax-ation permits all farmers to collect a higher degree of rents than if there were no taxation. The scheme that equalizes net rents across locations benefits farmers located at the tail of the system the most, while equalizing water charges provides adminis-trative simplicity. (Doria-PTT) W91-09441

# RATIONAL NATURE MANAGEMENT IN THE ZONE OF IRRIGATION OF THE KURA-ARAKS LOWLANDS.

R. G. Mamedov

N. O. Mamedov. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 423-425, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 4-6,

Descriptors: \*Drainage, \*Environmental protection, \*Irrigation design, \*Kura-Araks Lowland, \*Water conservation, \*Water resource management, Canals, Groundwater, Groundwater recharge, Saline soils, Salinity, Seepage control, Soviet Union, Water quality, Water shortage.

Negative ecological consequences result from the use of irrigation and drainage technology without consideration of natural and economic conditions. consideration or natural and economic conductors. If technical means of irrigation and drainage do not simultaneously conserve both resources and nature, then special nature conservation measures will not eliminate negative consequences, or will be very expensive. The example of the Kura-Araks Lowland (USSR) and reconstruction of the Upper Karabakh canal demonstrate that the degree of rational nature management is determined not so rational nature management is determined not so much by the damage from loss of water as a resource (despite long and persistent water shortage) as by the fact that these losses are accompanied by salinization of farmlands and by depreciation of the water quality in the Kura River. Groundwater investigations should be conducted when designing water management systems, to determine measures (such method of irrigation, load, drainage, reduction of the amount of irrigation recharge of groundwaters) that can prevent the occurrence of a critical situation. This complicates the problem of developing large agricultural-urthe problem of developing large agricultural-ur-banized territories such as Apsheron. All seepage control and drainage measures should be complet-ed before irrigation systems begin operation. When reconstructing canals and systems, seepage control and drainage measures are determined by the cost of water delivery, water shortage, high initial

# Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

# Group 3F-Conservation In Agriculture

groundwater level, need to create a flushing regime, and the possibility of using drainage waters. (Doria-PTT)

WATER RESOURCE MANAGEMENT MODEL FOR IRRIGATION VALLEY, MICHIGAN. THE SAGINAW

Michigan State Univ., East Lansing. Dept. of Re-

source Development.
C. He, T. C. Edens, and J. F. Bartholic.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 13-22. 2 fig, 6 tab, 14 ref.

\*Computer models Descriptors: Descriptors: "Computer models, "Decision making, "Irrigation requirements, "Model studies, "Streamflow forecasting, "Water demand, "Water resources management, Geographic information systems, Irrigation effects, Irrigation practices, Maize, Michigan, Saginaw Valley, Technology

A decision support system was developed to exam-ine the available streamflow for expanded irriga-tion in Michigan's Cass River Watershed. Data sets on weather, soil, and crop management were en-tered into a computer simulation model to estimate yield and irrigation water demand of corn on a 30year basis. The results indicate that seasonal irriga-tion water demand for corn averaged 163.1 mm 100 water demand for Corn averaged 10.3.1 mm (6.42 inches) for June through August, with 75.1 mm (2.96 inches) in July and 49 mm (1.93 inches) in August. Contrary to the irrigation demand, the streamflow in the Cass River is lowest in July and streamflow in the class River is lowest in July and August. Assuming instreamflow available for irrigation withdrawal is the amount above the National Pollutant Discharge Elimination System (NPDES) 95% exceedence flow limit, the maximum irrigation acreage the streamflow can sustain at 75% exceedence level is 7,800 acres, which only accounts for 23 percent of total arricultural land. accounts for 2.3 percent of total agricultural land accounts for 2.3 percent of total agricultural tand. Irrigation expansion exceeding this level would probably deplete the streamflow and damage or destroy the fishery habitat. Over the long term, improvement in irrigation efficiency and crop man-agement technology can support greater irrigated acreage without depleting the streamflow. In the mean time, additional sources of water, such as surface or aquifer storage of streamflow in spring should be sought to provide adequate water for irrigation expansion. (See also W91-09570) (Author's abstract)

SOIL LOOSENING AND DRAINAGE OF STRUCTURALLY UNSTABLE SILTY SOILS,

Department of Agriculture, Seale-Hayne Faculty of Agriculture, Food and Land Use, Polytechnic South West, Newton Abbot, Devon TQ12 6NQ, England.

For primary bibliographic entry see Field 2G. W91-09712

EVALUATING THE GREEN AND AMPT IN-FILTRATION PARAMETER VALUES FOR TILLED AND CRUSTED SOILS. International Inst. of Tropical Agriculture, Ibadan

For primary bibliographic entry see Field 2G. W91-09778

PROVIDING INFORMATION TO FARMERS FOR GROUNDWATER QUALITY PROTECTION.

Iowa Univ., Iowa City. Graduate Program in Urban and Regional Planning. For primary bibliographic entry see Field 5G. W91-09902

SIMULATED GROWING-SEASON PRECIPI-TATION AND NITROGEN EFFECTS ON WINTER WHEAT YIELD,

Montana Agricultural Experiment Station, Hunt-ley, MT. Southern Agricultural Research Center. For primary bibliographic entry see Field 2I. W91-09913

SOYBEAN CULTIVARS' RESPONSE TO FLOOD IRRIGATION OF CLAY SOIL.

Agricultural Research Service, Stoneville, MS.

Soybean Production Research Unit.
L. G. Heatherly, and H. C. Pringle.
Agronomy Journal AGJOAT, Vol. 83, No. 1, Agronomy Journal AGJOAT, Vol. 83, No. 1, p 231-236, January/February 1991. 5 tab, 28 ref.

Descriptors: \*Alluvial plains, \*Crop yield, \*Flood irrigation, \*Irrigation, \*Soybeans, Clay soils, Cultivars, Drainage, Rainfall, Soil water potential.

Surface irrigation is widely used to increase seed yield of soybean (Glycine max) grown on clayey soils of the southern Mississippi River alluvial plain. A field study was conducted on Sharkey clay (Vertic Haplaquept, very-fine, montmorillonitic, thermic) in 3 yr to measure the effect of flood insention of yearing duration on yield and yield uc, thermic) in 3 yr to measure the effect of flood irrigation of varying duration on yield and yield components of soybean. Treatments were (Treatment 0) nonirrigated; (Treatment 1) 24 h to flood (soil submerged 24 h after onset of irrigation) and then drained; (Treatment 2) 24 h to flood plus 24-h moving water flood, then drained; (Treatment 3) 24-h to flood plus 48-h moving water flood, then drained; (Treatment 4) as oil submerged with static drained; (Treatment 4) soil submerged with static water for 24 h, then drained; and (Treatment 5) soil submerged within 2 h of onset of irrigation, and then drained. All irrigation treatments commenced at first bloom and repeated whenever soil water potential of a treatment dropped minus 70 kPa at 30-cm depth. Cultivar Sharkey soybean was more responsive than was cultivar Centennial, but all irrigation treatments resulted in significant yield increases of both cultivars in years when rainfall was deficient during reproductive development. Treatment 3 flooding resulted in significantly lower seed yield than did Treatment 1 flooding, while Treatments 1 and 2 floodings achieved similar yield increases. In a rainy year (1988), Treatment 3 average yield was lower than yield from all other treatments. This indicates that even relativebiner treatments. This indicates that even relative-ly short periods of flooding can be detrimental to soybean if complemented with untimely rainfall. Standing water for 24 h (Treatment 4) produced yield increases that equalled or exceeded those of all the moving water treatments. These results showed that flood inundation of less than 48 h will result in the consistently largest significant yield increase for soybean, and that soybean genotypes differ in their response to flood irrigation. (Author's abstract) W91-09914

RESEARCH PLOT PLANTER FOR FURROW IRRIGATED CROPPING SYSTEMS.

Wyoming Univ., Powell. L. R. Bjornestad, and J. G. Lauer. Agronomy Journal AGJOAT, Vol. 83, No. 1, p 266-268, January/February 1991. 6 fig, 7 ref.

Descriptors: \*Agricultural engineering, \*Cropping systems, \*Farm equipment, \*Furrow irrigation, \*Furrows, Agricultural practices, Plot planter, Seed openers, Sprinkler irrigation.

Commercially available research plot planters are Commerciany available research plot painters are primarily designed for dry land and/or sprinkler irrigation systems. Research plot establishment in cropping systems involving furrow irrigation re-quires a planter with an adjustable drive system for diverse furrow spacings. Tool bars should have no interfering support brackets. These features will provide the flexibility needed for a wide range of row and furrow spacings. The planter was designed and constructed for establishing research plots in furrow-irrigated cropping systems. The planter drive wheels provide flexibility for furrow spacings ranging from 0.25 to 2.2 m. Two tool bars with no interfering support brackets allow numerous row spacing arrangements for seed and furrow openers. The planter can be adjusted quickly (approximately 1 h) for different furrow systems, and thus, used for research and/or extension demonstrates. (Author's abstract)
W91-09915

TILLAGE AND IRRIGATION EFFECTS ON ROOT GROWTH, SOIL WATER DEPLETION AND YIELD OF WHEAT FOLLOWING RICE.

Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils. M. R. Chaudhary, R. Khera, and C. J. Singh. Journal of Agricultural Science JASIAB, Vol. 116, No. 1, p 9-16, February 1991. 7 fig, 3 tab, 17 ref.

Descriptors: \*Crop yield, \*India, \*Irrigation efficiency, \*Plant growth, \*Rice, \*Soil water, \*Soilwater-plant relationships, \*Tillage, \*Wheat, Penetrometer resistance, Rainfall, Roots, Soil density, Soil physical properties, Soil profiles, Water use.

Rice cultivation leads to formation of a tillage pan. The hard pan, when formed, restricts root growth in crops following rice. The effects of deep tillage and no-tillage on soil physical properties and wheat yield following rice were compared with conventional tillage at three irrigation rates: (irrigation to the properties with the properties and the properties with the properties and the properties and the properties are consequently to the properties and the properties are consequently to the properties and the properties are properties. gation water using open pan evaporation ratios of 0.6, 0.9 and 1.2) in 1982-1985. Deep tillage detoo, 0.3 and 1.5 in 1962-1953. Deep lange de-creased soil bulk density and penetrometer resist-ance, and increased depth of rooting, profile water use and wheat yield. No-tillage adversely affected all these variables. The tillage effects varied with amount and distribution of rain during the cropping season. (Medina-PTT) W91-09936

CHANGES IN THE BASELINE OF THE CROP WATER STRESS INDEX FOR LUCERNE (MEDICAGO SATIVA) OVER 3 YEARS.

Agricultural Research Service, Shafter, CA. Cotton Research Station.

E. A. Rechel, W. R. DeTar, and D. Ballard. Journal of Agricultural Science JASIAB, Vol. 116, No. 1, p 63-66, February 1991. 2 fig, 1 tab, 12 ref.

Descriptors: \*California, \*Crop production, \*Crop water stress index, \*Irrigation practices, \*Lucerne, \*Water shortage, \*Water stress, Air temperature, Air vapor pressure, Mathematical models.

The ability to detect and measure water stress accurately is critical for optimizing crop produc-tion. The Crop Water Stress Index (CWSI), the linear relationship of the difference between folilinear relationship of the difference between foli-age and air temperatures as a function of the air vapor pressure deficit, is one widely used method. Under well-watered conditions, a baseline is de-rived that is crop specific and presumed fairly constant, despite differences in development and physiology. Changes in the baseline of the CWSI for lucerne crops not subjected to water shortage over 3 wears are reported. Studies of lucerne in tor lucerne crops not subjected to water shortage over 3 years are reported. Studies of lucerne in California from April 1986 to October 1988 used the CWS1 to plan irrigation. It was necessary to reestablish the baseline periodically throughout the experiment. In the first year it was similar to that reported in the literature, but in the second year it had a statistically significant steeper slope and higher intercept. In the third year, the regression equation was similar to that in the first year. The changes in the baseline are thought to be a result of crop age rather than year-to-year weather fluctuations. The baseline needs to be determined periodi-cally as the crop matures, to ensure accurate interpretation of plant water stress. (Author's abstract) W91-09937

CATCHMENT BASIN WATER HARVESTING AS A MEANS OF IMPROVING THE PRODUC-TIVITY OF RAIN-FED LAND IN UPLAND BA-LOCHISTAN.

Arid Zone Research Inst., Quetta (Pakistan). For primary bibliographic entry see Field 3B.

TOMATO FRUIT YIELDS AND QUALITY UNDER WATER DEFICIT AND SALINITY. California Univ., Davis. Dept. of Vegetable Crops. For primary bibliographic entry see Field 3C. W91-09958

WATER QUALITY EFFECTS ON SOILS AND ALFALFA: I. WATER USE, YIELD, AND NUTRIENT CONCENTRATION. North Dakota State Univ., Fargo. Dept. of Soil

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

# Conservation In Agriculture—Group 3F

For primary bibliographic entry see Field 3C.

WATER QUALITY EFFECTS ON SOILS AND ALFALFA: II, SOIL PHYSICAL AND CHEMI-

CAL PROPERTIES.
North Dakota State Univ., Fargo. Dept. of Soil

For primary bibliographic entry see Field 3C.

EFFECT OF EARTHWORMS ON THE AGRO-CHEMICAL AND HYDROPHYSICAL PROP-ERTIES OF IRRIGATED SIEROZEMS. Soyuzkhlopok Corporation, Tashkent, USSR. For primary bibliographic entry see Field 2G. W91-10014

TYPES OF STAGNANT MOISTURE ACCUMULATIONS IN SOILS OF HUMID LANDSCAPES AND THEIR MELIORATIVE AND AGRICULTURAL RATING.
Moscow State Univ. (USSR). Dept. of Soil Sci-

For primary bibliographic entry see Field 2G. W91-10016

REGULATION OF THE SOIL WARREGIME UNDER FURROW IRRIGATION. For primary bibliographic entry see Field 2G. W91-10017

DISCRETE OPTIMAL CONSTANT-VOLUME CONTROL FOR IRRIGATION CANALS.

Wyoming Univ., Laramie. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 7C. W91-10049

OPERATION AND MAINTENANCE SMALL IRRIGATION SCHEMES,

P. H. Stern. Intermediate Technology Publications Ltd., London. 1988. 45p.

Descriptors: \*Irrigation management, \*Irrigation practices, \*Water supply, Agricultural water, Drainage, Health aspects, Irrigation programs, Water demand, Water distribution.

The satisfactory operation and maintenance of an irrigation scheme depends upon the successful organization and coordination of human activities. Certain organizational problems can be attributed to bad planning and design. A badly designed system will produce many more operational problems than a well designed system which has taken into account all the necessary factors for smooth humans. The proper presentment of small-scale running. The proper management of small-scale irrigation schemes requires several types of activity which need to be regulated and coordinated, such as: (1) matters affecting the sources and delivery of as: (1) matters affecting the sources and delivery of the water; (2) the distribution of the water within the scheme; (3) the control of surplus water and drainage; (4) the maintenance of supply channels, drains, ditches and pipes; (5) the operation and maintenance of pumping machinery, channel regu-lators and structures; (6) the maintenance of roads and tracks; and (7) the implementation of agricul-tural operations which do not conflict with the and tracks; and (') the implementation of agricultural operations which do not conflict with the interests of neighbors or the general interests of the community. This manual deals with these problems of operation and maintenance at the source of supply and in the conveying of water in pipes or open channels. Water distribution is described both on-farm and off-farm along with the maintenance of irrigation systems and devices. In addition, advice is given on drainage, health and general management problems. (Lantz-PTT) W91-10059

WATER-PUMPING DEVICES: A HANDBOOK FOR USERS AND CHOOSERS.

TT Power Ltd., Eversley (England).
For primary bibliographic entry see Field 8C.
W91-10062

SATELLITE REMOTE SENSING FOR AGRI-CULTURAL PROJECTS. International Bank for Reconstruction and Devel-

opment, Washington, DC.
For primary bibliographic entry see Field 7B.
W91-10084

ROLE OF REMOTE SENSING IN IRRIGA-TION MANAGEMENT: A CASE STUDY ON ALLOCATION OF IRRIGATION WATER. For primary bibliographic entry see Field 7B. W91-10090

MONITORING OF NATURAL RENEWABLE RESOURCES AND CROP FORECASTING IN SAHELIAN COUNTRIES.

For primary bibliographic entry see Field 7B. W91-10093

STUDY OF HYDROLOGICAL REGIMES IN EXPERIMENTAL BASINS IN RELATION TO CULTIVATION PRACTICES. Institutul de Meteorologie si Hidrologie, Bucharest

Romania). For primary bibliographic entry see Field 2B. W91-10122

UTILIZATION AND CONSERVATION OF EURYALE FEROX SALISBURY IN MITHILA

(NORTH BIHAR), INDIA.
Department of Botany, C. M. Science College, Darbhanga-846 004, Bihar, India. For primary bibliographic entry see Field 2H. W91-10166

INVESTIGATION OF AERATION POROSITY IN SOILS UNDER IRRIGATION, Moscow State Univ. (USSR). Dept. of Soil Sci-

Y. V. Shein, I. I. Gudima, and L. Y. Bandina. Soviet Soil Science SSSCAE, Vol. 22, No. 3, p 127-130, 1990. 3 fig, 1 tab, 11 ref.

Descriptors: \*Irrigation effects, \*Pore size, \*Soil aeration, \*Soil physical properties, \*Soil porosity, \*Soil water, Density, Moisture content, Soil aggregates, Soil density, Soil gases, Soil saturation.

One of the basic elements of soil productivity is optimal soil aeration. In soils under irrigation, there are long periods of elevated moisture content which lead to a prolonged and severe decrease in the specific volume of air. Such periods when soil aggregates are 'flooded' necessarily affect the course of biological, chemical, and other processes. The problem of investigating the air content of the soil has two main phases: (1) establishing its quantitative characteristics and (2) developing experison has two man phases. It bestoushing its quantitative characteristics and (2) developing experimental approaches to the study of the dynamics of these characteristics in the soil profile with allowance for all the operative factors. The bulk density of the soil and aggregates, soil particle density, and the real soil moisture must be known. The air content in the soil can be evaluated in terms of differential soil porosity. Soil-height meters can be used to assess the dynamics in bulk density of the soil with all its interstices and cracks. By categorization soil with all its interstices and cracks. By categorizing differential porosity (allowing for the changes in the volumes of soil and aggregates due to their moisture content and the pressure of the overlying layers), the air regime of the soil can be analyzed in sufficient detail. Thus, the times and depths at which a shortage of air exists in the soil or soil aggregates can be determined. (Brunone-PTT) W91-10192

PROCEEDINGS OF: SOUTH TEXAS IRRIGA-TION CONFERENCE.

January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. 146p. Edited by Guy Fipps.

Descriptors: \*Conferences, \*Drip irrigation, \*Irrigation efficiency, \*Irrigation practices, \*Texas, \*Trickle irrigation, \*Water use efficiency, Agricultural chemicals, Electricity, Frost protection, Groundwater management, Pumping, Regional

planning, Reviews, Sprinkler irrigation, Well

The 1991 south Texas Irrigation Conference was held on January 15 in Hondo, Texas. Articles in these proceedings are meant to serve as reference material and do not cover all topics presented by the 28 speakers at the Conference. Topics covered include water quality and irrigation, well design and construction, pumping costs, chemigation, drip and microirrigation equipment, and high frequency and alternate methods of LEPA irrigation. Other areas discussed are alternatives to ditch transport of water, automatic feedback control of furrow irrigation, irrigation for cold protection, load management programs for irrigation, and the Edwards Aquifer near San Antonio. In addition, possible effects of the new Texas Water Plan on irrigated agriculture are explored. Information from these proceedings can be used to reduce water and proceedings can be used to reduce water and chemical use in irrigated agriculture while improv-ing their effectiveness. This also lowers costs, pro-tects water quality, and will help insure sustainable irrigation in the future. (See W91-10446 thru W91-10460) (VerNooy-PTT) W91-10445

NEW TEXAS WATER PLAN: IMPLICATIONS FOR IRRIGATED AGRICULTURE.

Texas Water Development Board, Austin. For primary bibliographic entry see Field 6B. W91-10447

WATER QUALITY AND IRRIGATION.

Texas A and M Univ., College Station. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 5G. W91-10448

IRRIGATION WELL DESIGN AND CONSTRUCTION.

Texas Agricultural Experiment Station, College For primary bibliographic entry see Field 8A. W91-10449

EFFECT OF OPERATING PRESSURE AND IRRIGATION EFFICIENCY ON PUMPING

Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8C.
W91-10450

SUCCESSES AND FAILURES OF LOAD MAN-AGEMENT PROGRAMS FOR IRRIGATION.
Texas A and M Univ., College Station. Dept. of

Agricultural Engineering.
For primary bibliographic entry see Field 6B.
W91-10451

HIGH FREQUENCY LEPA IRRIGATION.

Texas Agricultural Experiment Station, Lubbock. W. M. Lyle, and J. P. Bordovsky.

N. Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 71-80. 4 tab, 3 ref.

Descriptors: \*Crop yield, \*Irrigation efficiency, \*Irrigation practices, \*Sprinkler irrigation, \*Texas, \*Water use efficiency, Agricultural runoff, Corn, Cotton, Farm management, Irrigation effects, Onions, Reviews.

The low energy precision application (LEPA) irrigation concept was developed primarily to allow irrigators in arid and semi-arid areas to maximize the use of their total water resource and significantly increase irrigation efficiencies. Followin initial agronomic tests, extensive multi-year LEPA crop irrigation studies were begun to determine optimum LEPA irrigation management techniques based on water availability. This availability ranges from adequate to extremely limited in the Southern High Plains of Texas where LEPA was developed.

# Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

# Group 3F-Conservation In Agriculture

Initial testing began on onions followed by cotton and then corn. The most extensive study has been on cotton, however, additional data continues to on corton, nowever, auditional data continues to be assimilated for other crops. Almost without exception (excluding vegetables), favorable yield responses are obtained from alternate furrow irri-gation and is possible only with LEPA if a moving gation and is possible only with LEPA if a moving irrigation system is involved. Crops also respond to irrigation frequency and in general more frequent irrigation produces higher yields. This enhances the LEPA irrigation method because it decreases runoff potential. There are also interactions between the quantity of water applied and the frequency with which it is applied on crop yield. (See also W91-10445) (VerNooy-PTT)

# RESEARCH DEVELOPMENTS IN CHEMIGA-TION. Texas Agricultural Experiment Station, Prairie

View. J. P. Bordovsky, and W. M. Lyle.

J. P. Bordovsky, and w. M. Lye. IN: Proceedings of: South Texas Irrigation Confer-ence, January 15, 1991, Hondo, Texas. Texas Agri-cultural Extension Service, College Station. 1991. p 81-91. 1 fig. 9 tab, 4 ref.

Descriptors: \*Agricultural chemicals, \*Application rates, \*Chemcontrol, \*Chemigation, \*Irrigation design, Agricultural runoff, Canopy, Data interpretation, Farm management, Insecticides, Irriga-tion efficiency, Nozzles, Reviews, Runoff rates, Sprinkling, Texas, Tracers, Water pollution pre-

The multi-functional irrigation system (MFIS) was designed to provide precision application of both irrigation water and chemicals. Several years of testing at the Texas Agricultural Experiment Station (TAES) have been devoted to verifying the in-canopy application superiority of pesticides over traditional application methods. Excellent results with the moving nozzles on the MFIS prompted development of a simpler, stationary in-canopy nozzle package that sprayed chemical solutions in a upward pattern to the underside of plant leaves. Results of MFIS coverage test with tracers and insecticides and preliminary results of stationary in-canopy tests are reported. Dynamic in-canopy chemigation methods were consistently superior to traditional overhead application and aerial applica-The multi-functional irrigation system (MFIS) was traditional overhead application and aerial applica-tion in terms of plant coverage based on tracer and efficiency tests. Stationary in-canopy chemigation nozzles gave comparable results to the dynamic nozzle system. The in-canopy application methods offer very positive environmental possibilities due to excellent control achieved with new environmentally sound materials and with very low rates of existing pesticides. A chemigation simulator has been constructed at the TAES to help evaluate the differences in commercial chemigation nozzles and those used in the described tests. (See also W91-10445) (VerNooy-PTT) W91-10453

#### CHEMIGATION WITH LEPA CENTER

Texas Agricultural Extension Service, Texas A&M

University, Amarillo, TX. L. New, A. Knutson, and G. Fipps

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 92-98. 1 fig. 5 ref, 5 tab.

Descriptors: \*Agricultural chemicals, \*Application rates, \*Chemcontrol, \*Chemigation, \*Irrigation design, \*Irrigation engineering, \*Nozzles, \*Water conservation, Canopy, Corn, Farm management, Insecticides, Irrigation effects, Irrigation efficiency, Miticides, Reviews, Sprinklers, Texas, Water replictive respective. pollution prevention.

Application of appropriate amounts of fertilizer and pesticides by an irrigation system often reduces crop production costs while curtailing nonpoint source pollution. A low energy precision application (LEPA) chemigation mode was developed and extensively tested during the 1987 and 1988 growing seasons in Texas, primarily on corn to evaluate insecticide applications. The LEPA

chemigation mode was designed to direct water and chemical upward into the lower and higher crop canopy. Coverage of the underside of lower corn leaves with LEPA chemigation of Comite(TM) and Capture(TM) provided excellent control of spider mites. Contact miticides, such as Comite, can be successfully used on post-tassel stage corn when chemigated through LEPA systems. LEPA nozzles should be positioned 15 to 47 cm (6 to 18 in) above the ground to treat the underside of lower corn leaves for spider mites. Non-emulsified cottonseed oils at 1.75 L to 2.34 L/ Non-emulsined cottonseed onls at 1.73 L to 2.34 L7
ha (1.5 to 2 pints/acre) should be mixed with
Comite, Capture or dimethoate before injection for
spider mite controls. Insecticides applied for
Southwestern and European corn borers are effective when chemigated with LEPA systems if the
spray reaches above the ear regions. Uniform control of mites and borers has been observed under not on fitted and borers has been observed under electrical-driven (start-stop) LEPA center pivots applying all irrigation water. (See also W91-10445) (VerNooy-PTT) W91-10454

# ALTERNATE METHODS OF LEPA IRRIGA-

Texas Agricultural Experiment Station, Lubbock.

In: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 100-104.

Descriptors: \*Irrigation design, \*Irrigation efficiency, \*Nozzles, \*Sprinkler irrigation, \*Water conservation, \*Water use efficiency, Agricultural practices, Economic aspects, Energy use efficiency, Farm management, Hydraulic systems, Irrigation engineering, Irrigation operation, Texas.

Numerous variables affect the application efficiency and distribution uniformity of gravity and sprinkler irrigation systems. The LEPA (low energy precision application) system was designed to be relatively insensitive to these variables and to greatly minimize the water losses associated with them. General specifications for LEPA modifica-tion include drop tubes, location (alternate furrows), attachment of drop tubes, nozzles, hydraulic design and distribution uniformity. The LEPA system was designed primarily for semi-arid cli-mates where irrigation evaporation losses are sigmates where irrigation evaporation losses are sig-nificant and efficient utilization of rainfall is neces-sary; however, the energy savings aspects low pressure LEPA operation would also make it at-tractive in more humid areas. The cost to equip a system for LEPA irrigation depends upon the fol-lowing: (1) use of an old or new system, (2) row width, (3) every furrow or alternate furrow design, width, (3) every furrow or alternate turrow design, (4) need for pressure regulators, and (5) type of nozzeling required. Potential water savings can range from 20 to 40%, and energy savings of 30 to 50% can be realized depending upon the type system replaced. Yields have averaged 10 to 20% higher than those obtained either with furrow or sprinkler irrigation and have been equivalent to or in some tests higher than drip irrigation on both vegetable and field crops. In areas where the LEPA concept has been demonstrated, and particularly on farms where a portion of an existing sprinkler system has been modified to demonstrate the concept, the conversion rate to LEPA has been nearly 100% even though investment capital has been limited in the last few years. (See also W91-10445) (VerNooy-PTT) W91-10455

# ECONOMICS ALTERNATIVES TO DITCH TRANSPORTATION OF WATER,

R. M. Seymour. IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 105-114. 10 tab, 2 ref.

Descriptors: \*Cost-benefit analysis, \*Economic evaluation, \*Estimated costs, \*Irrigation ditches, \*Pipelines, \*Water conservation, \*Water loss, Construction costs, Conveyance structures, Cost analysis, Economic aspects, Economic feasibility, Irriga-tion water, Soil types.

Each year water for irrigation use becomes more and more expensive. Unlined ditches, although not used today as much as in the past, are still a source of lost water that cost the irrigator. In many cases of lost water that cost the irrigator. In many cases the cost of irrigation water lost from unlined ditches could be decreased by replacing unlined ditches with closed piping systems for water conveyance. The economic potential of replacing unlined ditches with a closed pipeline is discussed. Soils used and water loss data were taken from a Texas High Plains Water Conservation District 1979 Report. The five soils chosen represent a wide range of textural classes. Two methods of estimating the cost of water lost through unlined irrigation ditches were used. The first estimate of cost determined the total cost of pumping the water lost through seepage and evaporation in ditches. The second estimate was based on potential productivity the water losses could provide if used for irrigation. In addition to costs of unlined ditch losses, the cost of several types of ditch conveyance systems for 1990 were estimated. Each producer needs to evaluate his own situation. Get-ting an estimate on the amount of water lost in his unlined ditches is the first step in deciding if a pipeline system would be cost effective. Two exnples illustrate how to analyze costs and benefits Investigation of a variety of soils and wells showed that at least 90% of the time an irrigation pipeline system would pay for itself in water saved in much less time than the life of the system. (See also W91-10445) (VerNooy-PTT)

# AUTOMATIC FEEDBACK CONTROL OF FURROW IRRIGATION.

Texas A and M Univ., College Station. Dept. of

Agricultural Engineering. E. A. Latimer, and D. L. Reddell.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 115-126. 3 fig. 3 tab. 5 ref.

Descriptors: \*Automation, \*Furrow irrigation, \*Instrumentation, \*Irrigation efficiency, \*Irrigation engineering, \*Process control, \*Uniform flow, \*Water conservation, Cost analysis, Economic yield, Flow control, Flow regulators, Irrigation operation, Remote sensing, Sensors.

An automated furrow irrigation system is described. This experimental advance rate feedback scribed. This experimental advance rate feedback irrigation system (ARFIS) can significantly reduce tailwater losses and achieve high uniformities. ARFIS is composed of four systems: (1) a water sensing system to detect the irrigation advance front, (2) a flow control system to control the inflow discharge to the furrow, (3) a programmable process control system (computer) to manage and operate the irrigation system, and (4) a telemetry system that enables the computer to communicate with the other two systems. ARFIS furrow cate with the other two systems. ARFIS furrow irrigation has been evaluated in the field and with computer simulations. ARFIS automatically senses the advance of water at two preselected distances down the furrow. These advance-rate data are used to determine the infiltration function of the furrow. The predicted infiltration function is used to manage the irrigation event and to achieve the to manage the irrigation event and to achieve the targeted application depth. A cost analysis of ARFIS for a typical Texas irrigation scenario is presented. The annual net return for an eleven-furrow ARFIS setup over a conventional furrow system was \$12/ha (\$30 acre) using a radio telemetry system and \$37/ha (\$91.5/acre) using an infrared telemetry system. (See also W91-10445) (Author's abstract) thor's abstract) W91-10457

#### OVERVIEW OF DRIP/MICRO IRRIGATION PRODUCTS.

Texas Agricultural Extension Service, Fort Stockton, TX.

J. Henggeler.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 127-131. 1 fig.

# WATER QUANTITY MANAGEMENT AND CONTROL-Field 4

# Control Of Water On The Surface—Group 4A

Descriptors: \*Drip irrigation, \*Irrigation efficiency, \*Irrigation engineering, \*Trickle irrigation, Filters, Pipelines, Sprinklers, Valves, Water use effi-

Drip irrigation, also called trickle irrigation, is now generally referred to as micro-irrigation. It is a form of irrigation where water leaves the irrigation form of frigation where water leaves the frigation system in very close proximity to the irrigated plant. To do so, large amounts of pipe and tubing are required in microirrigation. Since micro-irrigation makes use of small-orifice water delivery devices such as emitters and micro-sprinklers, vices such as emitters and micro-sprinklers, it is important that the water be extraordinarily clean. This is done with filters, ie, sand filters, screen filters, or disk filters, and also with the aid of stilling tanks and sand separators. Other micro-irrigation system components are the valves, mains and sub-mains, lateral lines, and water emitting de-vices include emitting lateral, emitters, and micro-posibles. The mice intention water members are less than the com-position of the mice intention water than an elecsprinklers. The micro-irrigation system can also have other components such as a chemical injecnave other components such as a chemical injection system, flow meters, and pressure gages. The added cost associated with micro-irrigation is hopefully offset by additional yield and/or less water cost. (See also W91-10445) (VerNooy-PTT) W91-10458

# PREVENTION OF MICROIRRIGATION EMIT-

TER CLOGGING. Florida Univ., Gainesville. Dept. of Agricultural Engineering.

Engineering.

A. G. Smajstrla.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 132-139. 1 tab, 6 ref.

Descriptors: \*Clogging, \*Drip irrigation, \*Irrigation operation, \*Sprinklers, \*Trickle irrigation, \*Water conservation, Agricultural water, Algal control, Chemical treatment, Farm management, Fertilization, Filtration, Flushing, Hydraulic systems, Particulate matter, Reviews, Scaling, Water unative Water treatment. quality. Water treatment.

Microirrigation systems offer many advantages to Agricultural irrigators, especially increased yield and reduced water use due to improved water and nutrient management. However, a major problem with the use of microirrigation is the potential for system failure due to emitter clogging. Emitter clogging can result from inert particulate matter (particles of sand, silt or clay), biological organisms (algae or bacteria), or chemical precipitates (scale). targate or bacterial, of chemical precipitates (scale). Fertilizer injection into microirrigation systems can also contribute to emitter clogging. The potential for clogging can be estimated from a water quality analysis. The prevention of clogging almost always requires water filtration, chemical water treatment, good fertilization management, and router first to the contribution of contribution of the contribution of contribution of contributions. titue flushing of pipelines. Common chemical treatments include chlorination, acid treatment to lower the pH to reduce chemical precipitation, use of scale inhibitors, and pond water treatment (eg, copper sulfate) to control algal growth. Microirrigation systems normally require a higher level of management than conventional irrigation systems includes frequent inspections and the use of flow meters and pressure gauges to verify that systems are working as defined. (See also W91-10445) (VerNooy-PTT)

# MICROSPRAYER IRRIGATION FOR COLD

PROTECTION.
Texas A and M Univ., Weslaco. Agricultural Research and Extension Center. J. W. Sauls.

J. W. Sauls. IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991.

Descriptors: \*Cold resistance, \*Frost protection, \*Irrigation effects, \*Orchards, \*Sprinkling, Agricultural practices, Air temperature, Farm management, Freezing, Ice formation, Irrigation practices, Meteorological data, Peaches, Sprinklers, Temperature of Cological data, Peaches, Sprinklers, Temperature, Peaches, Sprinklers, Temperature, Peaches, Sprinklers, Peaches, Peach

Effective cold protection is often needed for consistent production of many temperate and subtropi-cal crops in Texas. Irrigation is an essential or-chard production practice that can also be used for cold protection under the right conditions. Over-head sprinkler irrigation has been so extensively studied and tested under various freeze conditions that the amount of water that must be applied to provide cold protection under various meteorological conditions is well known. Although the exact teal conditions is well known. Although the exact mechanism by which microsprayer irrigation provides cold protection is not fully understood, it is clear that under the proper conditions of operation, microsprayers can prevent the temperature of plant tissues from falling to damaging levels. From current data, it is reasonable to expect excellent protection from microsprayers delivering more than 16 gph and positioned about 3 feet high inside the center of a peach tree under radiant inside the center of a peach tree under radiant inside the center of a peach tree under radiant spring frost conditions. The ultimate objective is to save the bloom/crop, but the question of whether or not the grower's efforts were responsible must be answered in order to draw accurate conclusions about the effectiveness of cold protection efforts. For that reason, accurate temperature records must be developed both outside the orchard as well as inside. (See also W91-10445) (VerNooy-PTT) W91-10460

### 4. WATER QUANTITY MANAGEMENT AND CONTROL

### 4A. Control Of Water On The Surface

VISUAL INTERPRETATION OF SATELLITE IMAGERY FOR MONITORING FLOODS IN

Lakehead Univ., Thunder Bay (Ontario). Dept. of

For primary bibliographic entry see Field 7C. W91-09368

# WATER MANAGEMENT OF THE RIVER RHINE: PAST, PRESENT AND FUTURE. Rijksinstituut voor Zuivering van Afvalwater, Le-

lystad (Netherlands). van der Kleij, R. H. Dekker, H. Kersten, and J.

European Water Pollution Control, Vol. 1, No. 1, p 9-18, January 1991. 6 fig, 3 tab, 18 ref.

Descriptors: \*Rhine River, \*River basin management, \*River management, \*Water pollution conment, \*River management, \*Water pollution con-trol, \*Water resources management, Drinking water, Ecosystems, Flood plains, Flooding, Inter-agency cooperation administrative agencies, Inter-national agreements, Sluices, Water quality, Water

The present condition of the river Rhine is a result of one-sided management aimed only at flooding security and shipping route maintenance. For some decades now, river management has also been aimed at amelioration of the water quality, leading to ecological restoration in recent years (compared to the all-time water quality low in 1970). The to the an-time water quanty low in 1909. The Sandoz calamity has demonstrated that the protec-tion of the drinking water supply and of the river's ecosystem was still insufficient. Further restoration of the river ecosystem necessitates, next to water quality improvement, morphological adjustments as well as consideration of the relationship between the river and its floodplains. Only integral river management makes this restoration possible, where all interests and functions of the river are consid-ered from the beginning of every project, and optimal solutions are sought through cooperation of all disciplines concerned. This water resources management program is based on four tracks: pro-tection against pollution, hydraulic design, guided use of the river, and organization and instrumenta-tion of all necessary uses of the river. Concrete actions already begun include fish corridors being constructed at weirs and existing corridors or sluices being repaired and nature development

projects in the forelands of the river Rhine. A strengthening of international cooperation is necessary. In the future, perhaps the Rhine will be managed by an international water authority. (Brunone-PTT) W91-09374

### DITCH DRAINAGE IN LAYERED SOILS.

Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Irrigation and Drainage Engineering. H. C. Sharma, H. S. Chauhan, P. N. Kapoor, and

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 184-200, March/April 1991. 11 fig, 1 tab, 32 ref.

Descriptors: \*Drainage ditches, \*Drainage systems, \*Flow models, \*Mathematical models, \*Model studies, \*Soil physical properties, Design criteria, Drainage engineering, Hydraulic conductivity, Percolation, Permeability, Soil profiles, Soil

Theories available for the design of drainage sys-tems have been developed by assessing the soils to be homogeneous and isotropic. This assumption leads to erroneous results. The analytical solution developed based on six assumptions: (1) The drainage medium consists of two stratified layers that age mention consists of two stratifies upers una are homogeneous and isotropic within themselves; (2) the phreatic aquifer lies over a horizontal im-permeable bed; (3) the rate of replenishment from recharge is less than the hydraulic conductivities of soil layers; (4) deep percolation moves vertically downward until joining the water table; (5) Dupuit-Forchheimer assumptions are valid; and (6) the drains are equally spaced open-ditch drains, cutting through the phreatic aquifer down to the impermeable bed. Results show that the hydraulic conductivity of the lower layer significantly affects conductivity of the lower layer significantly affects the design spacing of drains. Even for small thicknesses of the lower layer, a higher hydraulic conductivity value significantly affects the design. Comparison with experimental observations in a simulated two-layer soil medium showed that for smaller values of elapsed time the predicted elevasmaller values or elapset time the preduced reva-tion of simulated water tables near the drain was less than that observed in the experiments. As the elapsed time increased, the predicted values of water tables near the drains were found in close proximity to the observed values. These results indicate that the proposed analytical solution compared well with experimental results and can be adopted for field applications for the design of drainage systems in two-layered soils. (Brunone-W91-09393

DRAINAGE OF CLAY OVERLYING ARTE-SIAN AQUIFER. 1: HYDROLOGIC ASSESS-MENT.

California Univ., Davis. Dept. of Land, Air and Water Resources.

M. E. Grismer, and I. C. Tod.

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 255-270, March/April 1991. 12 fig, 2 tab, 22 ref.

Descriptors: \*California, \*Confined aquifers, Descriptors: "California, "Confined aquiters, "Drainage systems, "Groundwater movement, "Imperial Valley, "Subsurface drains, Agriculture, Backfill, Clays, Flow profiles, Irrigation, Percola-tion, Permeability, Root zone, Saline soils, Saturat-ed soils, Soil types, Soil water, Trenches.

The performance of subsurface drains in a clay soil overlying an artesian aquifer is evaluated at a site in Imperial Valley, California. Prior to irrigation, the surface layer of soil is dry with cracks in the soil to a depth roughly equivalent to the rooting depth of the crop. Below the rooting depth of the crop, soil moisture content increases significantly within a few centimeters and visible cracking diwithin a few centimeters and visible cracking di-minishes. During irrigation, large surface cracks fill very rapidly with water, and soil adjacent to the cracks becomes quickly saturated. The net-work of cracks within the top layer is sufficient to saturate the soil throughout the top layer soon after the passing of the irrigation advance front.

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# Group 4A-Control Of Water On The Surface

Peak drain flow occurrs shortly after irrigation is Peak drain flow occurrs shortly after irrigation is stopped; and increase in drain flow results from flow down the backfilled trench above the drain line. Soil water and drain water salinity have remained nearly constant throughout the year, changing little over the past several decades. The drains intercept only a small percentage of deep percolation water and do not contribute significant of the past several decades. percolation water and do not contribute significantly. These results indicate the complexity associated with the analysis of subsurface-drainage system performance or efficiency in removing excess percolation from the root zone, because of the different sources of water contributing to drain flows and drainage characteristics of the soil profile. Field surveys conducted as part of the drainage system design process should address both probable sources of drain flows and soil drainage characteristics, so that the information could be used to check assumptions involved in drain spacecharacteristics, so that the information could be used to check assumptions involved in drain spacing equations, probable drain water quality, and other aspects of the design process. (See also W91-09398) (Brunone-PTT) W91-09397

DRAINAGE OF CLAY OVERLYING ARTESIAN AQUIFER. II: TECHNICAL ANALYSIS. C. Tod, and M. E. Grismer.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 271-284, March/April 1991. 7 fig, 3 tab, 15 ref.

Descriptors: \*Confined aquifers, \*Drainage systems, \*Groundwater movement, \*Mathematical models, \*Subsurface drains, Clays, Flow distribution, Model studies, Percolation, Permeability, Root zone, Salinity, Saturated soils, Soil types, Soil

Subsurface drains in clay soil overlying a shallow artesian aquifer intercept water from the aquifer and the deep percolation from the root zone. Flow down the backfilled drain-line trench is significant immediately after irrigation. The zone of influence of such drains is very limited, and only a small of such drains is very limited, and only a small percentage of deep percolation is intercepted by the drains. A quasi-transient, finite element mathematical model was constructed to simulate these different sources of flow contributing to the total drain flow in a subsurface drainage system in a clay coil overlying an artesian aquifer. The model was calibrated with field data gathered with piezometer water level measurements and drain flow hydrographs. The trench flow component decreased linearly with time at a rate much less than the actual exponential rate of decrease in trench flows. Trench flow variation with time could be closely approximated by drainage of an initially saturated vertical column of soil. Field data and model results indicate that three sources contribute saturated vertices couldn't some requirements of some results indicate that three sources contribute to drain flow: trench flow, deep percolation flow, and groundwater flow. On-farm water management can be improved with a better understanding of the sources contributing to drain flows. Information on trench flows is useful because: (1) if the peak drain outflow rate and the time of its occurpeak drain outflow rate and the time of its occur-rence are known, irrigations on adjacent borders can be scheduled to reduce overcharging of the collector drain system; (2) the salimity of drain water is less during trench flow and hence may be more suitable for reuse; and (3) if the characteris-tics of trench flow are known and trench flow is considered undesirable, methods to reduce trench flow can be evaluated. For example, trench flow could be reduced by inserting a less permeable layer in the backfilled trench. The less permeable layer could be a specially compacted layer of soil or an impermeable sheet (for example, a plastic sheet) placed in the backfilled trench below the plough layer or the root zone. (See also W91-09397) (Brunone-PTT) W91-09398

CONVECTIVE MOTIONS IN THE SIDEARM

OF A SMALL RESERVOIR.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W91-09409

ANNUAL PEAK DISCHARGES FROM SMALL DRAINAGE AREAS IN MONTANA THROUGH SEPTEMBER 1989.

Geological Survey, Helena, MT. Water Resources For primary bibliographic entry see Field 2E.

USE OF PALEOFLOOD INVESTIGATIONS TO IMPROVE FLOOD-FREQUENCY ANALYSES OF PLAINS STREAMS IN WYOMING. Geological Survey, Cheyenne, WY. Water Resources Div. For primary bibliographic entry see Field 2E. W91-09549

IMPROVING MANAGEMENT OF INTRA-STATE AND INTERSTATE WATER TRANS-FER IN THE EASTERN UNITED STATES. Virginia Polytechnic Inst. and State Univ., Blacks-For primary bibliographic entry see Field 6E. W91-09567

TRINIDAD RESERVOIR OPERATIONS POLICY DECISION SUPPORT SYSTEM.

TOTAL TREATMENT STORY STORY STORY

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 55-60. 2 fig. 7 ref.

Descriptors: \*Decision making, \*Model studies, \*Multiobjective planning, \*Reservoir operation, \*Water use, Boating, Competing use, Computer models, Computers, Conservation, Irrigation programs, Irrigation water, Recreation, Reservoir fisheries, Technology transfer, Water rights.

A Reservoir Operations Policy Decision-Support System (ROPDSS) was developed for the Trini-dad Reservoir and irrigation system located in southern Colorado. The decision support system was directed to a proposal to purchase irrigation water rights and establish an expanded conserva-tion pool in the Trinidad Reservoir to enhance the reservoir fishery, boating recreation, and develop-ment of terrestrial wildlife habitat on 1500 acres of ment of terrestrial wildlife habitat on 1500 acres of the project presented difficulties in assessing the feasibility of the proposed water right purchase and formulating an acceptable operating policy. The interactive decision-support strategy used in ROPDSS was comprised of visualization of targets, iconic simulation, and multiobjective trade-off analysis. User evaluation indicated general acoff analysis. Oser evaluation indicated general acceptance and even enthusiasm for the approach. While many aspects of the prototype ROPDSS are specific to the Trinidad Reservoir system, the concepts used in the system are general in their potential for application in other situations. (See also W91-09570) (Author's abstract) W91-09576

ELARC: HYDROLOGIC FORECASTING FOR FLOODPLAIN MANAGEMENT WITHIN THE POTOMAC RIVER BASIN--PHASE I. National Weather Service, Harrisburg, PA. For primary bibliographic entry see Field 6F. W91-09591

SEASONAL VARIATION OF CLOGGING OF AN ARTIFICIAL RECHARGE BASIN IN A NORTHERN CLIMATE, North Dakota State Water Commission, Bismarck.

W. M. Schuh

Journal of Hydrology JHYDA7, Vol. 121, p 193-215, December 1990. 9 fig, 2 tab, 36 ref.

Descriptors: \*Artificial recharge, \*Clogging, \*Recharge basins, Carbonates, Clays, Drying, Hydraulic properties, Impedance, Infiltration rate, Iron compounds, Seasonal variation, Sediment transport, Soil profiles, Soil types, Suspended solids.

The decrease of infiltration rate, and the depth, The decrease of infiltration rate, and the depth, cause, and hydraulic effect of clogging, were evaluated for a sandy, artificial-recharge test basin during the application of water containing between 51 and 61 mg/L suspended solids. Infiltration rate deceased by two orders of magnitude under fall operational conditions for a clean sand surface.

Clogging was caused by clay deposition within the basin soil profile during early operation times (19-75 h) followed by the complete interception of sediment in the surface filter cake during later sectiment in the surface inter case during later operational times. Impedance decreased by two to three orders of magnitude in the surface 8 cm, and by zero to two orders of magnitude from 8 to 38 cm. Increased clay content following basin operation was measured to a depth of 5 cm. During the spring test, sediment movement and deposition were similar to the fall test. In addition, carbonates were similar to the fall test. In addition, carbonates and iron oxyhydroxides precipitated, causing cementation of the surface soil grains. The cementation caused increased hydraulic impedance and resulted in a decrease of total recharge. Carbonate precipitation was caused by increased basin-water pH resulting from algal photosynthesis. Allowing the basin to dry and crack for ten days resulted in a substantial recovery (64%) of infiltration rate. Following the drying restreet the basin realocation. substantial recovery (64%) of infiltration rate. Following the drying treatment the basin reclogged more quickly than for the previous test on clean sands, and the impedance of the surface layer reached values larger than those prior to the drying treatment. The decrease of impedance caused by drying was confined to the surface layer, and no effect was observed below 8 cm. Following the natural drying treatment, total recharge was about half that of the clean basin. (Author's abstract) W91-09719

ADAPTIVE PREDICTION OF HYDROLOGIC SERIES BY WALSH-KALMAN MODEL.

Technical Univ. of Istanbul (Turkey). Dept. of

Civil Engineering.
For primary bibliographic entry see Field 2E. W91-09743

ANALYSIS OF FLOW INTO DRAINTILE IN THREE-DIMENSIONAL FLOW FIELD.

Lakehead Univ., Thunder Bay (Ontario). Dept. of Civil Engineering. For primary bibliographic entry see Field 2G. W91-09750

ANALYSIS OF PERIODICITY IN STREAM-FLOW AND RAINFALL DATA BY COLWELL'S INDICES.

Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering.
For primary bibliographic entry see Field 2A.

EFFECT OF IRRIGATION ON DAMBO HY-DROLOGY: A CASE STUDY.

Loughborough Univ. of Technology (England). Dept. of Civil Engineering. R. D. Faulkner, and R. A. Lambert. Journal of Hydrology JHYDA7, Vol. 123, No. 1/ 2, p 147-161, February 1991. 3 fig, 4 tab, 28 ref.

Descriptors: \*Africa, \*Arid-zone hydrology, \*Irrigation effects, \*Irrigation engineering, \*Model Descriptors: "Africa, "Ard-zone hydrology, "Irrigation effects, "Irrigation engineering, "Model studies, "Watershed management, "Wetlands, "Zimbabwe, Agricultural engineering, Aquifer systems, Cultivation, Evapotranspiration, Irrigation programs, Water resources management.

Dambos are small valley wetlands commonly found on the plateau regions of eastern and south-ern Africa. They are used for cattle grazing, cultivation, and as a source for domestic water supply. In Zimbabwe, up to 20,000 hectares of dambo land are being cultivated. This has developed through the initiative of local people largely without any external assistance and sometimes with active offi-cial discouragement, justified by concern over soil degradation and water resource depletion. A hy-drological model of a dambo has been developed, drological model of a dambo has been developed, based on two concatenated aquifers with the upslope dryland aquifer having only indirect access to the stream. It was found that irrigated cultivation, on the upper dambo zone, effectively uses water from this dryland aquifer and has little effect on streamflow. The principal effect on streamflow is in the early wet season baseflow, which is of little consequence. Cultivation without irrigation will have minimal effect on water resources. It was

### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

# Control Of Water On The Surface—Group 4A

estimated that, in a normal year, irrigated cultivation would increase dry season evapotranspiration on the upper dambo zone by 30%. If one-third of the area of the dambo studied (or 10% of the total catchment area) were to be fully irrigated, then catchment area) were to be rully irrigated, then such an increase in evaportanspiration would lead to an additional 9% (0.15 m) depletion in aquifer storage. These results suggest that a safe limit on the extent of irrigated cultivation on a dambo is 10% of the catchment area or 30% of the dambo area, whichever is the smaller. It was indicated that dambos offer significant potential for an expansion in irrigated cultivation. From the total of 250,000 ha of dambo land in Zimbabwe's commuand areas, there is a potential to expand present cultivation up to a maximum of approximately 80,000 ha. This has important implications for policy-makers in agriculture and irrigation, and for all those concerned with food security and nutri-W91-09786

FLOOD-FREQUENCY DERIVATION FROM KINEMATIC WAVE.

Northwest Hydraulic Consultants, Inc., Kent, WA. For primary bibliographic entry see Field 2E. W91-09813

EFFECTS OF CHANNEL MODIFICATIONS ON THE HYDROLOGY OF THE CHICOD CREEK BASIN, NORTH CAROLINA, 1975-87. Geological Survey, Raleigh, NC. Water Resources For primary bibliographic entry see Field 2E. W91-09823

FLOODS IN WEST VIRGINIA, VIRGINIA, PENNSYLVANIA, AND MARYLAND, NOVEM-

Geological Survey, Towson, MD. Water Re-For primary bibliographic entry see Field 2E. W91-09837

REVIEW OF SELECTED WATER-MANAGE-MENT MODELS AND RESULTS OF SIMULA-TION OBSERVATIONS FOR THE TRUCKEE-CARSON RIVERS SYSTEM, CALIFORNIA AND NEVADA.

Geological Survey, Reston, VA. For primary bibliographic entry see Field 2E. W91-09849

S-GRAPH STUDY FOR MARICOPA COUNTY,

Maricopa County Flood Control District, Phoenix,

Mancopa AZ.

J. Rumann, and G. V. Sabol.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A1-A6. 2 fig, 2

\*Flood forecasting, Descriptors: \*Arizona. Descriptors: \*Arizona, \*Flood forecasting, Graphical analysis, \*Hydrograph analysis, \*Hy-drographs, \*Unit hydrographs, Discharge meas-urement, Flood control, Flood data, Flood protec-tion, Floods, Hydrologic models, Hydrology, Nonstructural alternatives, Surface water, Water-

S-graphs were identified for use in the Urban Hyorgraphs were unentiment or use in the Urban ray-drograph Procedure was carried out for Maricopa County, Arizona, as part of a study to develop uniform flood studies in the County. A total of 53 S-graphs were compiled from the southwestern United States-35 individual S-graphs from flood reconstitutions for specific watersheds, 18 regional reconstitutions for specific watersheds, 18 regional S-graphs developed by graphically averaging several individual S-graphs that were representative of particular physiographic areas, or by modifying an individual S-graph. A general prediction equation for Lag was developed based on watershed characteristics which were documented where available. It was possible to synthesize S-graphs that reproduced the general shape of S-graphs that had been developed from flood reconstitution; S-graphs could be synthesized based on an investiga-

tion of the synthesis of S-graphs from Clark unithydrographs. S-graphs synthesized by unithydrograph procedures may be preferable to the selection of a limited number of S-graphs. However, the selection of either regional S-graphs or empirical unit hydrographs for the Urban Hydrograph Procedure should consider: (1) who the users of the procedure will be, and their ability and willingness to accept the procedure; (2) whether similar results will be obtained by all users; and (3) how close results from the procedure are when compared to those of an accepted standard. (See also W91-10018) (Korn-PTT) tion of the synthesis of S-graphs from Clark unit-

LOWER MISSISSIPPI RIVER STAGES FORE-

CASTING SYSTEM.
Tulane Univ., New Orleans, L.A. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C. W91-10021

COMPLEX WATERSHED MODELS IN FLOOD CONTROL: QUESTIONS OF CREDIBILITY. California State Univ., Fullerton. Dept. of Applied For primary bibliographic entry see Field 7C. W91-10026

URBAN WATERSHED RAINFALL-RUNOFF MODELING: A CASE STUDY. Texas A and I Univ., Kingsville. For primary bibliographic entry see Field 7C.

OPTIMAL DESIGN OF STORM DRAIN SYS-

TEMS.
ASL Consulting Engineers Pasadena, CA.
J. Han, and A. R. Rao.
IN: Computational Hydrology '87. Lighthouse
Publications, Mission Viejo. 1987. p C4-C8. 5 fig, 2

Descriptors: \*Design criteria, \*Design standards, \*Hydrologic models, \*Model studies, \*Storm drains, \*Storm water management, \*Surface runoff, \*Urban watersheds, Costs, Data interpretation, Design storms, Drainage systems, Frequency analysis, Storm runoff, Urban drainage.

A method to determine the optimal urban drainage design has been developed and used for a drainage network in West Lafayette, Indiana. The method combines a hydrologic model, the Illinois Urban Drainage Area Simulator (ILLUDAS), with a dynamic programming model to allow the assessment of the effects of hydrologic conditions and design of the effects of nydrotogic conditions and design criteria on the minimum cost of the drainage system. The model was tested by using data from the Upper Ross-Ade Watershed. The model was also used to investigate the variation of drainage system costs and variation in design parameters such as duration and frequency of storm and ante-cedent moisture condition. For any given water-shed, there exists a critical duration which produces the highest peak runoff, and hence the highest costs. It was found that these system costs varied more for the lower design frequencies than for higher frequencies. The least-cost model develfor higher frequencies. The least-cost model developed for the study was easy to apply, practical to use, and a considerable amount of information could be obtained from the model. The model was helpful to engineers in the design parameters which are traditionally selected by using engineering judgement. (See also W91-10018) (Korn-PTT) W91-10030

APPLICATION OF SMALL AREA UNIT HY-DROGRAPH METHOD.

King Civil Engineering Corp., Placentia, CA. For primary bibliographic entry see Field 7C. W91-10031

MASTER PLAN OF DRAINAGE-APPLICA-TION OF A USER-FRIENDLY COMPUTER MODEL.

Advanced Engineering Software, Irvine, CA.

For primary bibliographic entry see Field 7C. W91-10032

WE NEED A HYDROLOGY MANUAL.

Floodplain Management Division, Kern County Department of Planning and Development Services, California. For primary bibliographic entry see Field 7C. W91-10041

DIVERSION STRUCTURE FOR PEAK FLOW REDUCTION.

Rivertech, Inc., Laguna Hills, CA H. Nouri.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p H1-H3. 3 fig.

Descriptors: \*Design criteria, \*Detention reservoirs, \*Diversion structures, \*Flood control, \*Flood discharge, \*Hydraulic structures, \*Water control, Costs, Flood crest, Flood protection, Mathematical analysis, Mathematical studies, Runoff, Surface water.

The flood control requirements of a planned development in the City of Orange, California were such that the peak discharges from annual floods up to the 25-year return period, can be significantby reduced. It was required that the design discharge (25-year) be reduced not only to offset the increased runoff as a result of the development, but to alleviate some of the existing drainage problems downstream from the development. Because of the high cost of land, the conventional detention basin design did not present the most cost-effective solu-tion. A special inlet/outlet diversion structure was tion. A special inlet/outlet diversion structure was therefore analyzed and designed to convert a planned park into a detention basin during peak flow periods for the specified range of recurrence intervals. The extensive interaction between engineers and landscape architects resulted in a solution which was cost-effective, had low maintenance costs, and only infrequently disturbs the park operation. (See also W91-10018) (Author's abstract) abstract) W91-10047

STORMWATER RETENTION CRITERION FOR URBAN DRAINAGE BASIN MANAGE-MENT.

Erie and Associates, Phoenix, AZ.

I. Frie

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p H4-H8. 3 fig.

Descriptors: \*Design criteria, \*Flood control, \*Retention, \*Storm runoff, \*Storm water management, \*Urban runoff, \*Water control, Computer programs, Detention reservoirs, Flood discharge, Flood frequency, Flood peak, Hydrographs, Land use, Planning, Surface water, Watershed management

In an effort to reduce the frequency and magnitude of flooding in the Salt River Valley (Phoenix Area), all of the major governmental subdivisions have set policy requiring the onsite retention of storm runoff. The only unifying feature, however, to these various policies is that the volume to be extended to the property of the prop to these various policies is that the volume to be retained is expressed in terms of some combination of frequency and duration. To test the relative effectiveness of these policies in reducing runoff, a one square mile control watershed was created. Combinations of watershed slope, land use and Comonations of watersney stope, and use and storm frequency were superimposed on the basin with the four different valley policies and eight alternate policies, to determine resulting runoff. The results are compared to runoff generated from both the watershed without retention and to runoff from the basin prior to development with the result from the easin prior to development with the testin that while retention is very effective in reducing runoff from smaller more frequent storms (2 yr., 5 yr., etc.), certain policies (10 year-2 hr capacity and below) have little influence on larger storms such as the 100 yr. storm. Retention may even have the effect of increasing storm water runoff. In order to reduce flooding in areas where significant damage would not occur from 'natural runoff' for a 100 year storm or less, the minimum retention

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# Group 4A-Control Of Water On The Surface

criterion which should be considered is the 10 year-24 hr. runoff volume. (See also W91-10018) (Author's abstract) W91-10048

SIMULATION MODELING AND DATA COL-LECTION IMPACTS ON RESERVOIR CON-

TROL DECISIONS.
Corps of Engineers, Detroit, MI. Detroit District.
J. F. Gauthier, J. R. Weiser, and M. R. Skeels.
IN: Computational Hydrology '87. Lighthouse
Publications, Mission Viejo. 1987. p H24-H31. 5

Descriptors: \*Data acquisition, \*Model studies, \*Reservoir operation, \*Simulation analysis, Automation, Computer models, Decision making, Flood control, Gaging stations, Lake Winnebago, Man-agement planning, Mathematical studies, Network design, Reservoirs, Surface water.

In 1980, the Detroit District Corps of Engineers In 1980, the Detroit District Corps of Engineers assumed control of the outlet dams of the 6,430 square mile Lake Winnebago, Wisconsin basin. An evaluation was made of the incremental benefits attributable to additional modeling or data collection in basin management. The simulation plots demonstrated that improvements in reservoir management were possible, but forecasting of inflows did not provide gains for this system. The modeling results were useful of the formulation of management strategies but advance knowledge was ing results were useful of the formulation of man-agement strategies, but advance knowledge was not critical in making the daily operation choices. This assumed that the water control manager knew the outflow, stage and inflow for the current period. Since the implementation of the satellite-based data collection system, real-time basin wide data was available to make daily water control decisions. The system geometry dictated that outflow was strongly dependent on stage. Therefore, advance notice of a spring flood event did not significantly aid management decisions since the declining stage reduced the maximum possible outflow, thus limiting the reservoir's capacity to pass flood flows. Significant low outflow periods have generally been characterized by long periods have generally been characterized by long periods of low inflow rather than short term conditions. Suc-cessful management of low flow was dependent on a sound strategy based upon analysis of prior events of concern. It was shown that further improvements or additions to the present data collection system would not provide significant benefits for the basin water control management. (See also W91-10018) (Korn-PTT) W91-10051

INDIAN BEND WASH: THE INTEGRATION OF RECREATION, FLOOD CONTROL, AND LAND USE.

Erie and Associates, Phoenix, AZ.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p 110-114. 1 fig.

Descriptors: \*Flood control, \*Flood plain management, \*Land use, \*Project planning, \*Recreation, \*Urban areas, Alternative planning, Cost analysis, Costs, Flood channels, Flood damage, Flood plain zoning, Flooding, Open space, Storm runoff, Urban planning

The Indian Bend Wash runs 7 miles (eleven kilometers) through the center of the City of Scottsdale, Arizona. Periodic flooding has occurred in the normally dry wash resulting in increasing damage in areas adjacent to the 1000 foot (300 meter) wide channel. In 1965, Congress authorized the construction of a concrete channel as a solution the construction of a concrete channel as a solution to this repeated flooding. However, because of the wash location, Scottsdale citizens felt that the concrete channel would divide the city. In the late sixties, the City, in cooperation with the U. S. Army Corps of Engineers and Maricopa County Flood Control District, formulated and adopted the greenbelt concept as an alternative for control-ling flooding which would incorporate a number of recreational features. This project is unique in that recreation features and higher density land uses are integrated into the flood control channel so that the 7 mile (eleven kilometers) reach of the

wash through Scottsdale will provide over 1200 ac. (700 hectares) of environmentally compatible, recreational, open space. The City's unique flood plain ordinance and land use philosophy have been the key economic factors in bringing the concept to reality. Indian Bend Wash was honored by the National Society of Engineers in 1974 as one of ten outstanding engineering achievements in the United States because of its trend setting approach to urban flood control. (See also W91-10018) (Author's abstract)

EFFECT OF DETENTION BASINS ON PEAK WATERSHED DISCHARGES.

WATERSHED DISCHARGES. Renninger (William) Associates, Greenville, SC. S. E. Sonnenberg, and A. A. Fiuzat. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p J8-J13. 7 fig, 9

Descriptors: \*Data interpretation, \*Detention reservoirs, \*Flood peak, \*Hydraulic design, \*Storm water management, \*Surface runoff, \*Urban runoff, \*Watershed management, Design criteria, Discharge hydrographs, Hydraulic structures, Hydrograph analysis, Model studies, Urban drainage, Urban drainage,

The problem of managing increased stormwater runoff created by urbanization has resulted in many communities requiring the use of private detention facilities on all future developments. The effectiveness of such detention facilities has been examined and a simplified idealized watershed was assumed. Using the Modified Rational Method for calculating runoff, and a constant release rate detention facility model, discharge hydrographs were developed for different watershed conditions and detention facility design criteria. The results showed that while the use of detention facilities can reduce peak discharges for some watersheds, they can also increase peak discharges of the watershed depending on the circumstances. The length of time that detention facilities hold water, length of time that detention facilities hold water, called Design Holding Time (DHT), ia a good indicator of their effect on peak discharges. Typical design criteria for detention facilities presently practiced will result in increased peak discharges for most watersheds. Changing the design criteria such that the DHT equals the total watershed time of concentration, or the flow time from the bottom of the watershed, will result in no increase over peak developed discharges. (See also W91-10018) (Author's abstract) (Author's abstract) W91-10056

ENDOW USER'S GUIDE. Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. For primary bibliographic entry see Field 7C. W91-10060

APPLICATION OF OPTIMIZATION MODELS TO SYNTHETIC HYDROLOGICAL SAMPLES. Ruhr Univ., Bochum (Germany, F.R.). Lehrstuhl fuer Waserwirtschaft und Umwelttechnik I.

R. Harboe.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 151-160, 5 fig, 3 tab, 9 ref.

Descriptors: \*Model studies, \*Optimization, \*Reservoir operation, \*Synthetic hydrology, Dynamic programming, Hydroelectric power, Irrigation, Low-flow augmentation, Multiobjective planning, Reservoirs, Water supply.

Most of the mathematical models of water resources systems including reservoirs use synthetic hydrology to simulate the behavior of a system for hydrology to simulate the behavior of a system for a given operating rule. Optimization models offer the possibility of finding an optimal operating rule and, usually, deterministic models with historical records are proposed. Deterministic optimization models of a reservoir system were applied to syn-thetic hydrological samples, thus yielding many operating policies. This was possible because a sequential application of dynamic programming

was used in conjunction with a max-min and physi-cal objective function. The methodology was applied to a real-world system of four reservoirs in which low-flow augmentation was the main purpose. Five synthetic records were necessary in the system (the four inflows to the reservoirs and the flow at the control gage). The results show an acceptable variation in the statistical parameters of the synthetic records by comparison with the parameters of the historical records. The problem of dimensionality with four reservoirs was solved by using deterministic dynamic programming models for each reservoir in a sequence; the results of the optimization of one reservoir (increased low flows) optimization of one reservoir (increased low flows) are used as input for the optimization of the next reservoir (i.e., flow to be augmented is now higher). Application of a standard operating rule determined by multiobjective analysis gave low-flow targets for standard operating rules. If security of an operating rule is defined as the probability of success (no failure) with all given synthetic exceeds, then a multiobjective analysis can be perrecords, then a multiobjective analysis can be per-formed to select the optimal rule. The methodology has general validity and can be applied to other systems of reservoirs in which the main purpose is either hydropower, irrigation, or water supply. (See also W91-10103) (Fish-PTT) W91-10118

HYDROLOGY AND THE ENVIRONMENT: THE CASE STUDY OF SAO PAULO, BRAZIL. Sao Paulo Univ. (Brazil). Dept. de Hidraulica. For primary bibliographic entry see Field 6D. W91-10120

FLOODPLAIN FOREST ECOSYSTEM, PART I: BEFORE WATER MANAGEMENT MEAS-

Brno Univ. (Czechoslovakia). For primary bibliographic entry see Field 2H. W91-10298

# 4B. Groundwater Management

DITCH DRAINAGE IN LAYERED SOILS. Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Irrigation and Drainage Engineering. For primary bibliographic entry see Field 4A. W91-09393

DRAINAGE OF CLAY OVERLYING ARTE-SIAN AQUIFER, I: HYDROLOGIC ASSESS-MENT.

California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 4A.
W91-09397

DRAINAGE OF CLAY OVERLYING ARTE-SIAN AQUIFER, II: TECHNICAL ANALYSIS, For primary bibliographic entry see Field 4A. W91-09398

VARIATIONS IN ORGANIC AND ORGANO-LEPTIC WATER QUALITY DURING TREAT-MENT OF ARTIFICIALLY RECHARGED GROUNDWATER.

Lyonnaise des Eaux, Le Pecq (France). Lab. Cen-

For primary bibliographic entry see Field 5F. W91-09405

GIS PROVING GROUNDS FOR WATER RE-SOURCES RESEARCH.

Purdue Univ., Lafayette, IN. Water Resources Research Center For primary bibliographic entry see Field 7A. W91-09468

GROUNDWATER GEOCHEMISTRY AND RADIONUCLIDE ACTIVITY IN THE CAMBRIAN-ORDOVICIAN AQUIFER OF DODGE AND FOND DU LAC COUNTIES, WISCONSIN.

# Groundwater Management—Group 4B

Wisconsin Univ.-Madison. Dept. of Geology and Geophysics. For primary bibliographic entry see Field 2F.

W91-09470

SUMMARY OF DATA FROM THE 1981-83 PILOT STUDY AND 1985-89 OPERATIONS OF THE HUECO BOLSON RECHARGE PROJECT,

NORTHEAST EL PASO, TEXAS.

Massachusetts Inst. of Tech., Cambridge. Microsystems Technology Labs.

D. E. White, and G. J. Sladek.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-175, 1990. 38p, 10 fig, 15 tab,

Descriptors: \*Aquifer testing, \*Artificial recharge, \*Groundwater movement, \*Pumping tests, \*Recharge, \*Recharge, \*Recharge wells, Observation wells, Water level, Water quality.

Pumping and injection tests were conducted during a 1981-83 pilot study of the Hueco bolson recharge project in northeast El Paso. Water-level decline and buildup were measured in a recharge well and an observation well. The specific capacity of the recharge well during the October 1982 injection test was 18.3 gal/min/ft after 22.5 hours. The recharge well was redeveloped in June 1983. The specific capacity during the final pumping test of the pilot study was 27.5 gal/min/ft after 24.5 hours, compared to 35.8 gal/min/ft after 24.5 hours during the May 1981 pre-injection pumping test of the business of the Muser (1985-89) of operation of the Hueco bolson recharge project, water levels in the observation well were measured, and concentrations of selected water-quality constituents were trations of selected water-quality constituents were determined. Water levels in 6 production wells located 0.25 to 0.6 mile from the injection wells of notated 0.22 to 0.0 mue from the injection wells of the recharge project declined at a rate of about 2 ft/yr prior to 1985. Since 1980, water-level meas-urements indicate that the effects of pumping and recharge are approaching equilibrium. (USGS) W91-09482

STREAM-AQUIFER SYSTEM IN THE UPPER BEAR RIVER VALLEY, WYOMING. Geological Survey, Cheyenne, WY. Water Resources Div.

For primary bibliographic entry see Field 2A. W91-09489

GROUND-WATER CONDITIONS IN THE GRAND COUNTY AREA UTAH, WITH EMPHASIS ON THE MILL CREEK-SPANISH VALLEY AREA.

Geological Survey, Salt Lake City, UT. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09492

GROUND-WATER RESOURCES AND SIMULATED EFFECTS OF WITHDRAWALS IN THE EAST SHORE AREA OF GREAT SALT LAKE, UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09498

HYDROGEOLOGY AND GROUND-WATER RESOURCES OF SOMERSET COUNTY, COUNTY.

Geological Survey, Dover, DE. Water Resources

For primary bibliographic entry see Field 2F. W91-09522

GEOLOGY AND HYDROLOGIC ASSESSMENT OF COASTAL PLAIN AQUIFERS IN THE WALDORF AREA, CHARLES COUNTY, MARYLAND.

Maryland Geological Survey, Baltimore. For primary bibliographic entry see Field 2F. W91-09523

GEOHYDROLOGY, GROUND-WATER QUALITY, AND SIMULATED GROUND-WATER FLOW, GEAUGA COUNTY, OHIO.
Geological Survey, Columbus, OH. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09534

HYDROLOGIC CONDITIONS AT ANAKTU-VUK PASS, ALASKA, 1989. Geological Survey, Anchorage, AK. Water Re-

sources Div. For primary bibliographic entry see Field 2F. W91-09541

WATER RESOURCES OF HUTCHINSON AND TURNER COUNTIES, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources

For primary bibliographic entry see Field 2F. W91-09543

APPLICATIONS OF DOWN-WELL/DOWN-WELL AND DOWN-WELL/SURFACE RESISTIVITY TECHNIQUES TO EVALUATE GROUND WATER FLOW IN FRACTURES. Connecticut Univ., Storrs. Dept. of Geology and Geophysics Geophysics.

For primary bibliographic entry see Field 2F. W91-09569

NUMERICAL MODEL USES AND LIMITATIONS FOR GROUND WATER MANAGEMENT.

Butler Univ., Indianapolis, IN. Holcomb Research Inst.

For primary bibliographic entry see Field 6A. W91-09582

QUANTITATIVE TECHNIQUES APPLICABLE TO PROTECTION OF WATER SUPPLY WELLS IN THE CHESAPEAKE BAY AREA. Geraghty and Miller, Inc., Reston, VA. Modeling Group.

For primary bibliographic entry see Field 5G. W91-09654

GROUNDWATER PROTECTION AND THE ROLE OF EDUCATION - AN APPRAISAL. Virginia Polytechnic Inst. and State Univ., Blacks-

burg. For primary bibliographic entry see Field 5G. W91-09656

HYDROGEOLOGY AND GROUNDWATER RESOURCES DEVELOPMENT OF THE CAMBRO-ORDOVICIAN SANDSTONE AQUIFER IN SAUDI ARBIA AND JORDAN, Birmingham Univ. (England). School of Earth Sci-

ences. For primary bibliographic entry see Field 2F. W91-09708

SEASONAL VARIATION OF CLOGGING OF AN ARTIFICIAL RECHARGE BASIN IN A NORTHERN CLIMATE.

North Dakota State Water Commission, Bisms For primary bibliographic entry see Field 4A. W91-09719

GROUND-WATER PUMPAGE FROM THE GULF COAST AQUIFER SYSTEMS, 1960-85, SOUTH-CENTRAL UNITED STATES. Geological Survey, Reston, VA. Water Resources

Div. For primary bibliographic entry see Field 2F. W91-09816

ARCHIVING OF DEEP PERCOLATION MODELS, DATA FILES, AND CALCULATED RECHARGE ESTIMATES FOR THE COLUM-BIA PLATEAU REGIONAL AQUIFER SYSTEM, WASHINGTON, OREGON, AND IDAHO.

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 2F. W91-09828

ESTIMATES OF GROUND-WATER RE-CHARGE TO THE COLUMBIA PLATEAU RE-GIONAL AQUIFER SYSTEM, WASHINGTON, OREGON, AND IDAHO, FOR PREDEVELOP-MENT AND CURRENT LAND-USE CONDI-TIONS TO THE PROPERTY OF THE PROPERTY TIONS

Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09831

GROUND-WATER GROUND-WATER AVAILABILITY AND QUALITY IN EASTERN BERNALILLO COUNTY AND VICINITY, CENTRAL NEW MEXICO

Geological Survey, Albuquerque, NM. Water Resources Div. For primary bibliographic entry see Field 2F. W91-09838

GROUND-WATER PUMPAGE FROM THE CO-LUMBIA PLATEAU REGIONAL AQUIFER SYSTEM, WASHINGTON, 1984. Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 6D. W91-09851

POTENTIAL FOR GROUND-WATER DEVELOPMENT IN CENTRAL VOLUSIA COUNTY, FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div. For primary bibliographic entry see Field 2F. W91-09853

GROUND-WATER RECHARGE IN FLORIDA-A PILOT STUDY IN OKALOOSA, PASCO, AND VOLUSIA COUNTIES. Geological Survey, Tallahassee, FL. Water Re-

Vecchioli, C. H. Tibbals, A. D. Duerr, and C. B.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4195, 1990. 63p, 3 pl, 4 fig, 4 tab, 22 ref.

Descriptors: \*Groundwater resources, \*Florida, \*Okaloosa County, \*Pasco County, \*Volusia County, \*Groundwater recharge, \*Base flow, Natural recharge, Groundwater runoff, Springs.

Protection of groundwater recharge areas against incursions of development is of great interest in Florida, a State whose population depends heavily on groundwater and that is experiencing rapid growth. The Florida Legislature is considering implementation of a program to provide favorable tax treatment to owners of high-rate recharge tax treatment to owners of high-rate recharge lands that are left in an undeveloped state. Implementation would require delineation of such lands at a scale large enough to be useful to tax assessors. The U.S. Geological Survey undertook a pilot study with the Florida Department of Environmental Regulation to explore the feasibility of mapping high rate recharge areas at a scale of 1:100,000. Maps at that scale were compiled for Okaloosa, Pasco, and Volusia Counties. These maps delineate areas of high-rate recharge to the surficial aquifer and to the Upper Floridan aquifer. High-rate recharge was arbitrarily set at 10 or more in/yr. Recharge rates were determined primarily through analysis of streamflow, spring flow, marily through analysis of streamflow, spring flow, and/or pumpage data together with knowledge of the groundwater flow system and topographic and soils information. If the pilot study is successful, similar maps may be prepared for other areas of the State. However, in some parts of the State, quantitative mapping of recharge may not be possi-ble although mapping on a qualitative basis is considered feasible. (USGS)

### Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# Group 4B-Groundwater Management

W91-09855

HYDROLOGY OF HEBER AND ROUND VALLEY, WASATCH COUNTY, UTAH, WITH EMPHASIS ON SIMULATION OF GROUND-WATER FLOW IN HEBER VALLEY. Geological Survey, Salt Lake City, UT. Water Resources Div.

Resources Div.
For primary bibliographic entry see Field 2F.
W91-09857

INFORMATIONAL NEEDS FOR LOCAL GROUNDWATER MANAGEMENT DECI-

SIONS.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
N. Dee, and M. Mlay.
Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 223-225, 1990. 2 fig.

Descriptors: \*Data requirements, \*Decision making, \*Groundwater data, \*Groundwater management, \*Local governments, \*Resources management, Computers, Costs, Data collections, Data storage and retrieval, Databases, Governmental interrelations.

In recent years, local governments have assumed more responsibility for management of groundwater and other environmental resources. Effective management of groundwater resources by all levels of government depends upon an adequate and accessible base of information Data manage-ment establishes the information base needed to ment establishes the information base needed to allow proper definition of resources and problems and the evaluation of prevention strategies. The fundamental objective of data management sys-tems, both computerized and manual, is to produce meaningful and timely information so that data analysts and managers can make decisions and carry our their responsibilities. Data management is an investment in resource management and pro-tection. The real challenge will be to use data management in the most cost-effective way to manage complex groundwater resources. (Feder-W91-09877

COMPREHENSIVE APPROACH GROUNDWATER MANAGEMENT RURAL LOCAL GOVERNMENTS. TO FOR

Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology. E. G. M. Meij, and C. W. Abdalla. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 226-239, 1990. 23 ref.

Descriptors: \*Comprehensive planning, \*Ground-water management, \*Local governments, \*Re-source management, \*Rural areas, \*Water policy, Alternative planning, Decision making, Environ-mental management, Groundwater pollution, Policy making, Public policy.

The comprehensive approach to groundwater management provides a method for increasing local capacity to manage environmental issues. It emphasizes the beginning stages of the policy process: problem definition, generation of alternatives and decision-making. These phases of the policy process consider information about the resource, the resource use, and values placed on current and future uses. This comprehensive approach can enter the comprehensive future uses. This comprehensive approach can en-hance rural local government groundwater policymaking by increasing community awareness, broadening problem ownership and supporting informed decisions. (Author's abstract)

CASE STUDIES IN RURAL GROUNDWATER MANAGEMENT. Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Dept. of Agricultural Economics. For primary bibliographic entry see Field 2E. W91-09886

CHARACTERIZATION AND CONTROL OF SHALLOW GROUND WATER CONDITIONS.

Leighton and Associates, Inc., Irvine, CA. For primary bibliographic entry see Field 2F. W91-10034

INTERFERENCE OF KANATS AND WELLS. Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

Engineering. A. R. Kia, and M. L. Albertson. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p D19-D26. 7 fig, 1 tab, 15 ref.

Descriptors: \*Groundwater management, \*Groundwater potential, \*Hydraulic structures, \*Kanats, \*Well construction, \*Well hydraulics, Aquifer characteristics, Aquifer systems, Artesian pressure, Confined aquifers, Drawdown, Drilling, Geohydrology, Mathematical studies, Unconfined aquifers, Water supply development, Well pumping, Wells.

A kanat is an underground tunnel of relatively flat slope which extracts water from a more steeply sloping aquifer under the force of gravity. The kanat concept and technology has been successfully used for more than 30 centuries in Central Asia, the Middle East, North Africa, and in South Eastern Europe as a very important technique for groundwater exploitation. The successful and longterm conjunctive use of kanats and wells in sloping aquifers is possible, when some discretion is used in aquifers is possible, when some discretion is used in the placing and pumping of wells, under many geological formations and aquifer combinations. The interference of a kanat and a well is mostly influenced by the relatively steeper slope and wider drawdown curve of the well in comparison with the kanat. This difference arises from the deeper penetration of the well into the aquifer in contrast with the kanat, and from the pumping of the well which causes greater drawdown. The case of a kanat drilled into a sloping unconfined aquifer, using the spilled excess water of a confined aquifer, using the spilled excess water of a confined aquifer. e most sensitive for interacting with wells. If is the most sensitive for interacting with wells. If the unexplored confined aquifer is used by drilling wells into it, the kanat will very likely dry up if there us a drop of even a few meters in the artesian pressure. If both kanats and wells have been drilled in one unconfined aquifer, the process of their interference is more gradual, due to the considerable wet tunnel length of the kanat. The range of groundwater table fluctuations must be determined for the purpose of the optimum exploitation using a combination of kanat and well technologies. (See also W91-10018) (Korn-PTT)

FEASIBILITY OF ARTIFICIAL RECHARGE TO THE OAKES AQUIFER, SOUTHEASTERN NORTH DAKOTA: HYDROGEOLOGY OF THE

NORTH DAKOTA: HYDROGEDLOGY OF THE OAKES AQUIFER.

North Dakota State Water Commission, Bismarck. R. B. Shaver, and W. M. Schuh.

North Dakota State Water Commission Water-Resource Investigation No. 5, 1990. 123p, 41 fig, 11 tab, 12 supp, 11 plates, 54 ref.

Descriptors: \*Artificial recharge, \*Feasibility studies, \*Geohydrology, \*Groundwater management, \*North Dakota, \*Oakes Aquifer, Aquifers, Groundwater irrigation, Groundwater quality, Groundwater recharge, Infiltration, James River, Missouri River, Model studies, Transmissivity, Water quality, Wells.

In December 1984, the Garrison Diversion Unit Commission recommended that a feasibility study be initiated to assess artificial recharge to the Oakes aquifer, southeastern North Dakota. Under the artificial recharge plan, the Oakes aquifer would function as a storage reservoir. Water would be diverted from the Missouri River to the James River and then into recharge facilities at selected sites in the aquifer. Withdrawals for irrigation would be from wells completed in the Oakes tion would be from wells completed in the Oakes aquifer. To fulfill project irrigation requirements, the Oakes aquifer must: (1) sustain a minimum withdrawal rate of 100 cu ft/see for 60 days (11,900 acre-ft), (2) pose no water quality limita-tions for irrigation, and (3) have initial surface infiltration rates of at least 1 ft/day. The area of the Oakes aquifer most feasible for the develop-

ment of both a well field to supply 11,900 acre-ft of ment of both a well field to supply 11,900 acre-it of water in 60 days and surface recharge facilities is within the channel fill deposits near sec. 13, T. 129 N., R. 59 W. An aquifer test conducted using an irrigation well completed in the channel, fill deposits in this area indicating a transmissivity of 94,000 q ft/day. Individual well yields of about 2,000 gal/min are attainable. A surface infiltration test gal/min are attainable. A surface infiltration test conducted in sands overlying the channel fill deposits in this area, indicated an initial infiltration rate of 2.5 ft/day, sufficient to support large-scale surface artificial recharge facilities. Although groundwater quality in the Oakes aquifer is variable, groundwater in the channel fill deposits is suitable for irrigation use. A finite difference model of the Oakes aquifer indicates that the channel fill deposits may be completely a first than the channel fill deposits may be completely as the control of the Oakes aquifer indicates that the channel fill deposits may be control of the Oakes aquifer indicates that the channel fill the oakes aquifer indicates that the channel fill of the Oakes aquifer indicates deposits near sec. 13, T. 129 N., R. 59 W. could deposits near sec. 13, 1, 129 N., R. 39 W. could sustain withdrawals required to meet periods of peak irrigation demand in the West Oakes and West Oakes extension irrigation development tracts of the Garrison Diversion Unit. (Author's abstract) W91-10063

GROUNDWATER RESOURCES IN EGYPT: POTENTIALS AND LIMITATIONS.

International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands). For primary bibliographic entry see Field 2F. W91-10121

STATUS AND TRENDS OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE SAN ANTONIO REGION.

Southwest Texas State Univ., San Marcos. For primary bibliographic entry see Field 6D. W91-10446

EFFECT OF OPERATING PRESSURE AND IR-RIGATION EFFICIENCY ON PUMPING COSTS.

Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8C.
W91-10450

### 4C. Effects On Water Of Man's Non-Water Activities

CUMULATIVE EFFECTS OF LAND MANAGE-MENT ON SOIL AND WATER RESOURCES: AN OVERVIEW.
Forest Service, Logan, UT. Intermountain Re-

search Station.

Search Station.

R. C. Sidle, and A. N. Sharpley.

Journal of Environmental Quality JEVQAA, Vol.

20, No. 1, p 1-3, January/March 1991. 27 ref.

Descriptors: \*Ecological effects, \*Environmental effects, \*Land management, \*Land use, Agricultural practices, Construction, Cultivation, Grazing, Herbicides, Logging, Nutrients, Pesticides.

The concept of cumulative effects encompasses a broader spectrum of resources and land uses than has typically been evaluated in research. As mannas typicany been evaluated in research. As man-agement pressures in large drainage basins intensi-fy, pristine areas may be subjected to multiple human activities. Timber harvesting, grazing, mining, recreation, site preparation, road construcmining, recreation, site preparation, road construc-tion, vegetation conversion as well as, agricultural applications of fertilizers, pesticides and herbicides can affect ecosystems both on site, and at great distances. Even though individual land uses may distances. Even though individual land uses may not significantly degrade environmental components such as soil productivity, water quality, or aquatic habitat, the combined effects of several activities may be unacceptable. Theoretically, cumulative effects of land management may also provide benefits to portions of ecosystems, such as increased the second of the productivity respected by a provide the productivity respected by the second of the productivity respected by the produ increased stream productivity generated by nutri-ent inputs. Cumulative effects of land management must also be evaluated within the context of natural processes and events, such as large storms, wild fire, geochemical weathering, and vegetation suc-cession. This overview provides examples of cu-

# Effects On Water Of Man's Non-Water Activities—Group 4C

mulative effects of land management and introduces the papers that were presented at a special symposium held during the American Society of Agronomy meetings in 1989. (Author's abstract) W91-09327

SALINITY, NITRATE AND WATER IN RANGELAND AND TERRACED WHEATLAND ABOVE SALINE SEEPS.

Southern Plains Range Research Station, Woodward, OK.

W. A. Berg, J. W. Naney, and S. J. Smith. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 8-11, January/March 1991. 4 fig, 20 ref.

Descriptors: \*Groundwater movement, \*Path of pollutants, \*Saline soils, \*Salinity, \*Seeps, Agricultural practices, Agricultural watersheds, Agriculture, Leaching, Nitrates, Oklahoma, Percolation, Seep water, Wheat.

Saline seeps have emerged over the past 20 yr in some Southern Plains soils, in Oklahoma, which are cropped annually to winter wheat (Triticum aestivum). Saline seep development is a cumulative process associated with percolation of small increments of water over many years through saline strata in recharge areas to build up water tables over less permeable strata in lower slope positions. In this study, soluble salt, nitrate, and water content were determined in Woodward soils (course silty, mixed, thermic Typic Ustochrepts) to a depth of 3 m in terraced farmland in adjacent native rangeland upslope from saline seeps. Significantly (P < 0.05) more soluble salt was present in the surface 3 m of rangeland than in adjacent farmland. No difference (P > 0.05) was found in soluble salt content in farmland between terraces as compared to soluble salt in terrace channels. Greater amounts (P < 0.05) of nitrate and water were in the 3 m profiles under farmland than under native range. The soluble salt profiles indicate more water has percolated through the farmland than the range-land. The implication is cultivated land, both in terrace channels and between terraces, is contributing salt and water to saline seep. An alternative explanation is terrace channels are the major recharge areas and lateral flow of this water leaches salt from farmland between the terraces. Using water before it percolates below the root zone is critical to the control of saline seep. Farm management practices such as rotating wheat with crops that have deeper roots such as sunflower, or use more water such as alfalfa, or double cropping of graze-out forage such as sorghum, may be useful in reducing seep formations. (Doyle-PTT)

MAIZE PRODUCTION IMPACTS ON GROUNDWATER QUALITY.
Nebraska Univ., Lincoln. Dept. of Agronomy.

Nebraska Univ., Lincoln. Dept. of Agronomy. J. S. Schepers, M. G. Moravek, E. E. Alberts, and K. D. Frank.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 12-16, January/March 1991. 5 fig, 1 tab, 9 ref.

Descriptors: \*Agricultural practices, \*Corn, \*Groundwater pollution, \*Nitrates, \*Nonpoint pollution sources, \*Path of pollutants, \*Water pollution sources, Agricultural runoff, Agriculture, Fertilizers, Leaching, Nebraska, Nutrients, Regulations

The cumulative effects of management practices on nitrate-nitrogen (NO3-N) leaching and ground-water quality are frequently difficult to document because of the time required for expression and the diversity of interacting processes involved. Cultural practices recommended by the Central Platte National Resource District (CPNRD) and reported by producers for the 1988 growing season, representing approximately 3900 fields covering 48,210 ha of irrigated corn (Zea mays), indicated NO3-N contamination of groundwater was influenced by yield goals and fertilizer N application rates. Groundwater NO3-N concentrations were positively correlated with residual N in the surface 0.9 m of 501 prior to the growing season, reflecting the effects of past N and water management prac-

tices. Yield goals in 1988 averaged 9% higher than the average 10.0 Mg/ha corn yield attained, which accounts for an average of about 20 kg N/ha in excess of the average N recommendation. By comparison, in the 1980 to 1984 study from an area within the CPNRD, yield goals averaged 28% greater than actual yields. Overly optimistic yield goals in 1988 accounted for 42% of the average excess N application rate of 48 kg/ha (based on University of Nebraska recommendations). A large portion of average excess N application is attributed to producers in 14% of the area who applied > 100 kg N/ha more than the recommended rates. Fertilizer A recommended. Better education and more stringent measures may be required to address the select group of producers who fail to follow CPNRD recommendations. (Author's abstract) W91-09329

MODELING THE CUMULATIVE WATER-SHED EFFECTS OF FOREST MANAGEMENT STRATEGIES.

Forest Service, Arcadia, CA. R. R. Ziemer, J. Lewis, R. M. Rice, and T. E.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 36-42, January/March 1991. 5 fig, 19 ref.

Descriptors: \*Environmental effects, \*Forest management, \*Forest watersheds, \*Logging, \*Model studies, \*Watershed management, California, Clear-cutting, Erosion, Mathematical models, Monte Carlo method, Oregon, Sediment erosion.

There is increasing concern over the possibility of adverse cumulative watershed effects from intensive forest management. It is impractical to address many aspects of the problem experimentally because to do so would require studying large watersheds for 100 yr of more. One such aspect is the long term effect of forest management strategies on erosion and sedimentation and the resulting damage to fish habitats. Dispersing activities in time and space may provide an effective way to minimize cumulative sedimentation effects. To test this hypothesis, Monte Carlo simulations were conducted on four hypothetical 10,000-ha fifth-order forested watersheds: one watershed was left undisturbed; the second was completely clear cut and roaded in 10 yr, with cutting starting at the head of the watershed and progressing toward the mouth; a third was cut at the rate of 1% each year beginning at the watershed's mouth and progressing upstream; and the fourth was cut at the rate of 1% each year beginning at the fourth was cut at the rate of 1% each year, with individual cut areas being widely dispersed throughout the watershed. These cutting patterns were repeated in succeeding centuries, rebuilding one third of the road network every 100 years. The parameters governing the simulation swere based on recent data from coastal Oregon and northwestern California. Mass wasting, the most important source of sediment in that environment, was the only hillslope process modeled. The simulation results suggest that; (1) the greatest differences between management strategies appeared in the first 100 yr and were related primarily to the rate of treatment. By the second 100 yr, when all watersheds had been treated, the principal difference between logging strategies was the timing of impacts; (2) Dispersing harvest units did not significantly reduce cumulative effects; and (3) The frequency of bed elevation changes between 1 and 4 cm is dramatically increased by logging. (Author's abstract)

PROBABILITY OF SEDIMENT YIELDS FROM SURFACE EROSION ON GRANITIC ROAD-FILLS IN IDAHO.

Intermountain Forest and Range Experiment Station, Boise, ID. For primary bibliographic entry see Field 2J. W91-09333

DOWNSTREAM EFFECTS OF TIMBER HAR-VESTING ON CHANNEL MORPHOLOGY IN ELKS RIVER BASIN, OREGON. Colorado Univ., Boulder. Inst. of Arctic and

Alpine Research.
S. E. Ryan, and G. E. Grant.
Journal of Environmental Quality JEVQAA, Vol.
20, No. 1, p 60-72, January/March 1991. 10 fig, 2
tab, 26 ref.

Descriptors: \*Channel morphology, \*Ecological effects, \*Elk River Basin, \*Environmental effects, \*Erosion, \*Forest management, \*Logging, Aerial photography, Forest watersheds, Forestry, Oregon, Riparian vegetation, River channels, Sedimentation.

Downstream effects are a type of cumulative watershed effect separated in time and space from the original landscape disturbance. Changes in the width and distribution of open riparian canopies in the Elk River Basin of southwest Oregon were measured from aerial photographs of densely forested basins taken between 1956 and 1979. Opening occurs when large disturbances, such as landslides, debris flows, large floods, and excessive sedimentation disrupt vegetation in the riparian corridor. Downstream changes in channel morphology, inferred by the changing pattern of open reaches, were linked to upstream forestry activities; a causal link was assumed where: (1) open reaches extended continuously downstream from clear cuts and roads, or (2) the timing and pattern of opening downstream varied in direct relation to the intensity of upslope forestry activities. Open reaches on low order tributaries were attributed to landslides and surface erosion caused by clearcuts and roads), and increased 30% during the study period. Limited downstream changes in the riparian canopy was attributed to three physical factors: (1) lack of debris flows in most parts of the basin, (2) channels constrained by competent hillslopes limiting the potential for opening, and (3) low harvest levels over much of the basin at the time of a 100-yr storm. Aerial photographic interpretation proved useful in deciphering the gross disturbance history of the basin and in distinguishing general processes which generate downstream effects. However, sedimentation processes that do not disturb the canopy are not detected by this technique. (Doyle-PTT)

WATER QUALITY IMPACTS ASSOCIATED WITH SORGHUM CULTURE IN THE SOUTH-ERN PLAINS.

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. A. N. Sharpley, S. J. Smith, J. R. Williams, O. R. Jones, and G. A. Coleman.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 239-244, January/March 1991. 2 fig, 3 tab, 31 ref.

Descriptors: \*Agricultural practices, \*Agricultural runoff, \*Nonpoint pollution sources, \*Tillage, \*Water pollution control, \*Water pollution sources, Description, Eutrophication, Kinetics, Nitrogen, Nutrients, Oklahoma, Phosphorus, Sediments, Sorghum, Surface runoff, Texas, Watersheds

Nonpoint source pollution of surface water by the transport of sediment, N, and P in agricultural runoff is one of the nation's major water quality concerns. Consequently, concentrations and amounts of sediment, N, and P in runoff from Conventional Till (CT), Reduced Till (RT), and No Till (NT), sorghum (Sorghum bicolor) watersheds in Southern Plains of Oklahoma and Texas, were measured during a 5-y period to evaluate water quality impacts of sorghum culture. Mean annual sediment and total N and P loss in runoff from NT (281, 0.76 and 0.28 kg/ha/yr) and RT (523, 0.99, and 0.37 kg/ha/yr) were lower than from CT sorghum (8877, 7.28, and 2.5 kg/ha/yr). In contrast, tillage effects on soluble N and P losses were generally small and less consistent, although soluble P concentrations exceeded limits associated with accelerated eutrophication (0.01 mg/L). Predicted losses of soluble P and particulate N and P using desorption kinetics and enrichment ratio relationships were not significantly different from measured values for all tillage practices (r-squared ranged from 0.66 to 0.99). Overall, conservation

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# Group 4C—Effects On Water Of Man's Non-Water Activities

tillage (NT and RT) reduced sediment, N, and P transport in runoff relative to CT and thereby lessened the potential impact of sorghum culture on surface water quality in the Southern Plains. (See also W91-09352) (Author's abstract) W91-09351

WATER QUALITY IMPACTS ASSOCIATED WITH WHEAT CULTURE IN THE SOUTHERN PLAINS.

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. S. J. Smith, A. N. Sharpley, J. W. Naney, W. A. Berg, and O. R. Jones.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 244-249, January/March 1991. 1 fig, 5

Descriptors: \*Agricultural practices, \*Agricultural runoff, \*Nonpoint pollution sources, \*Tillage, \*Water pollution control, \*Water pollution sources, Desorption, Kinetics, Nitrogen, Nutrients, Oklahoma, Phosphorus, Sediments, Surface runoff, Texas, Watersheds, Wheat.

Water quality information regarding wheat culture in the Southern Plains is sparse. The objective of this study is to determine the extent to which the area's surface and groundwater quality is influenced by different wheat cultural practices. Concentrations and amounts of sediment, N and P in surface runoff water were determined for conventional till (CT), reduced till (RT), and no till (NT) wheat (Triticum aestivum) watersheds in the High Plain, Reddish Prairie, and Rolling Red Plain land resource areas of Oklahoma and Texas. During the resource areas of Oklahoma and Texas. During the 4to 6 yr study periods, RT and NT practices were superior to CT for reducing sediment and associated particulate nutrient discharge. Mean annual discharge ranged from 230 to 15,900 kg/ha for sediment, 1 to 27 kg/ha for total N, and 0.1 to 6 kg/ha for total P. Irrespective of tillage practice, annual soluble nutrient losses in surface runoff tended to be small, often less than 1 kg/ha N or P. Successful practicity of soluble P. particulate P. and particulations. prediction of soluble P, particulate P, and particu-late N losses was achieved using appropriate kinet-ic desorption and enrichment ratio procedures. Soluble N in runoff posed no particular water quality problem, but recommended P levels were exceeded, even from baseline, unfertilized grassland watersheds. With regard to groundwater quality, elevated levels of NO3 (e.g., 34 mg N/L maximum) were observed on one Reddish Praire NT watershed. (See also W91-09351) (Author's abstract) W91-09352

AQUATIC NATURE OF INDIAN BOTAN-IC GARDEN LAKES.

Botanical Survey of India, Howrah (India). For primary bibliographic entry see Field 2H.

EFFECTS OF STORM RUNOFF ON WATER QUALITY IN THE WHITE RIVER AND FALL CREEK, INDIANAPOLIS, INDIANA, JUNE THROUGH OCTOBER 1986 AND 1987. Geological Survey, Indianapolis, IN. Water Re-

sources Div.
For primary bibliographic entry see Field 5B. W91-09495

LONG-TERM EFFECTS OF SURFACE COAL MINING ON GROUND-WATER LEVELS AND QUALITY IN TWO SMALL WATERSHEDS IN EASTERN OHIO.

Geological Survey, Columbus, OH. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-09556

CHANGES IN BIOTIC INTEGRITY OF A RIVER IN NORTH-CENTRAL TENNESSEE, Tennessee Technological Univ., Cookeville. Dept. of Biology.

W. D. Crumby, M. A. Webb, F. J. Bulow, and H. Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 5, p 885-893, September 1990. 3 fig, 5 tab, 19 ref.

\*Bioindicators, \*Environmental impact, \*Fish barriers, \*Roaring River, \*Sedimentation, \*Species composition, \*Stream biota, \*Tennessee, \*Watershed management, Agricultural practices, Aquatic habitats, Bridge construction, Dam effects, Dredging, Fish populations, Intro-duced species, Reservoirs, Water quality monitor-ing, Watersheds.

Fish species composition and index of biotic integrity of Roaring River, Tennessee, were assessed in 1972 and 1986. During the intervening years, a fish barrier dam was constructed in the river, heavy gravel dredging occurred, and the watershed was disturbed by bridge construction, highway con-struction, and poor agricultural practices. Species composition changes and a general decline in index values reflected these instream and watershed disturbances. Deliberate and inadvertent introduc-tions of new fish species also contributed to these changes. There was a general decline in number of native species, a loss of intolerant species in the native species, a loss of intolerant species in the lower reaches, and a general increase in tolerant species. There was also an increase in the number of introduced species in the lower reaches, and a general increase in percentage of the population consisting of introduced species. The index of biotic integrity was found to be useful in assessing habitat and water quality perturbations in Roaring River. Although recent water quality values were similar to those measured in 1972, it is believed that sedimentation may be primarily responsible to those measured in 1972, It is believed that sedimentation may be primarily responsible for declines in environmental quality of Roaring River. Future studies should include quantitative evaluation of sedimentation and habitat changes within the river. (Doria-PTT) W91-09768

RELATION BETWEEN URBANIZATION AND WATER QUALITY OF STREAMS IN THE AUSTIN AREA, TEXAS.
Geological Survey, Austin, TX. Water Resources

. E. Veenhuis, and R. M. Slade.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4107, 1990. 64p, 29 fig, 8 tab, 45 ref, 1 pl.

Descriptors: \*Austin, \*Surface water, \*Texas, \*Urban hydrology, \*Urban watersheds, \*Urbanization, \*Water pollution sources, \*Water quality, Base\_low, Statistical analysis, Stormflow, Urban

Selected water quality properties and constituents of stormflow and base flow at 18 sites on 11 streams in the Austin area, Texas, were compared to determine the relation between degree of urban-ization and water quality. Sample sites were grouped into four development classifications based on percentage of impervious cover of the drainage basin. For each site and development classification, concentrations and densities of water quality properties and constituents in samples collected during rising and falling stages of stormflow and during base flow were compared. Except for and during observed where the description of dissolved solids, concentrations during the rising stage of stormflow generally were larger than during the falling stage. The concentrations in stormflow were larger than in base flow. For the five sites that had sufficient samples from each flow category for statistical comparisons, median concentrations in stormflow were significantly larger than in base flow. Concentrations in the rising stage were more variable and significantly larger than in the falling stage. Except for dis-solved solids, median concentrations in samples collected during stormflow increased with increasing urbanization. Medians for base flow also were larger for more urban classifications. The ratio of the number of samples with detectable concentra-tions to total samples analyzed of 18 minor inortions to total samples analyzed of 16 minor inor-ganic constituents and the concentrations of many of these constituents increased with increasing ur-banization. Twenty-two of 42 synthetic organic compounds investigated were detected in one or more samples and were detected more frequently and in larger concentrations at sites with more urban classifications. (USGS)

W91-09835

SOIL PH AND ALUMINIUM AND THEIR SPA-TIAL VARIATION IN WESTERN AUSTRA-LIAN ACIDIC SOILS.

Western Australia Dept. of Agriculture, Northam. Avon Districts Agriculture Centre. For primary bibliographic entry see Field 2K. W91-09949

COMMUNITY STRUCTURE OF CORAL REEFS WITHIN THE VICINITY OF MOTOBU AND SESOKO, OKINAWA, AND THE EFFECTS OF HUMAN AND NATURAL INFLU-ENCES.

National Univ. of Singapore. Dept. of Zoology. L. M. Chou, and K. Yamazato. Galaxea, Vol. 9, No. 1, p 9-75, October 1990. 23

fig, 33 tab, 17 ref. Descriptors: \*Anthropogenic effects, \*Corals, \*Ecological effects, \*Marine environment, \*Okinawa,

\*Reefs, \*Siltation, \*Species composition, Construc-tion, Echinoderms, Land reclamation, Population

The community structure of 2 patch reefs and 8 fringing reefs within the vicinity of Sesoko and Motobu, Okinawa, was analyzed using belt tran-sects to determine the effects of human and natural influences. Recovery of the 2 patch reefs from the Acanthaster devastation from 1972-1973 was better for the inner patch reef (Nurun) than for the outer patch reef (Yakkai). The reef slopes of the seaward side of both patch reefs showed negligible recovery while the reef flat of Yakkai patch reef was replaced by a soft-coral community. Acropora was the dominant genus in terms of percent cover, species richness and colony number on the patch reefs. Damage to the reef community caused by typhoon Holly was slight, as the storm's center passed by in a northwesterly direction just south of Okinawa island. The fringing reefs along the coast of Motobu have developed different community characteristics largely through the conditions created by various types of man-made construction work. At each of these stations, different species of corals and reef-associated organisms dominate. At Ohama, where land reclamation and red silt runoff Onama, where iand reciamation and real sit runoin from the land have resulted in a very silty bottom, coral recovery was poor but a good variety of sea urchins (5 species) was present. Silty conditions persisted at Okobori river mouth and between Sesoko bridge and Hamasakibaru but at these 2 locations, coral growth was better and dominated by a prefer of over leaving. The very shaltered tocations, cotar growth was center and commande by a variety of coral species. The very sheltered conditions in Hamasaki port supported a community dominated mainly by the coral Porites lutea and the sea urchin Diadema setosum. The reefs at Komegobaru and Sakimotobu showed poor recovery rates with many small coral colonies, although substrate space was available and sediment-free substrate space was available and sediment-free. These 2 locations supported large populations of the sea urchin Echinometra mathaei. (Author's abstract) W91-09952

ACIDIFICATION INDUCED BY DIFFERENT NITROGEN SOURCES IN COLUMNS OF SE-LECTED TROPICAL SOILS.

International Fertilizer Development Center, Muscle Shoals, AL. For primary bibliographic entry see Field 5B.

LAND CLEARING AND USE IN THE HUMID NIGERIAN TROPICS: I. SOIL PHYSICAL PROPERTIES.

International Inst. of Tropical Agriculture, Ibadan (Nigeria). For primary bibliographic entry see Field 2G. W91-09968

MASTER PLAN OF DRAINAGE-APPLICA-TION OF A USER-FRIENDLY COMPUTER MODEL.

Advanced Engineering Software, Irvine, CA.

# Watershed Protection—Group 4D

For primary bibliographic entry see Field 7C. W91-10032

COMPARISON OF STREAMFLOW ROUTING PROCEDURES FOR HYDROLOGIC MODELS. California Univ., Davis. Water Resources Co For primary bibliographic entry see Field 7C. W91-10033

THEORY FOR DEVELOPMENT OF THE TR-55 TABULAR HYDROGRAPH METHOD. Haestad Methods, Westbury, CT. For primary bibliographic entry see Field 7C. W91-10040

HYDROGEOLOGIC ANALYSIS OF UNION CARBIDE'S A-19 PIT, EAST GAS HILLS, WYO-

MING.
Idaho Univ., Moscow. Dept. of Agricultural Engi-

Descriptors: \*Environmental effects, \*Geohydrology, \*Groundwater movement, \*Hydrologic models, \*Mine wastes, \*Model studies, \*Seepage, \*Waste disposal, Clay liners, Computer programs, Data interpretation, Drains, Hydraulic conductivity, Piezometers, Unsaturated flow, Water table, Wyoming.

The source of seepage causing an observed local water table rise in the upper Wind River aquifer was investigated near Union Carbide Corporation's A-9 tailings disposal pit in East Gas Hills, Wyoming. Based on computer simulation with the program UNSAT2, the observed rise in the upper Wind River piezometric surface near the A-9 pit was found to be due unsaturated flow from both the slime tailings and free water contact along the pit wall. The phreatic surface near the pit wall remained high because the slime tailings had a relatively low hydraulic conductivity; this created relatively low hydraulic conductivity; this created relatively low hydraulic conductivity; this created a significant source of seepage. A portion of the water table rise was attributed to seepage through the clay liner. The drains in the A-9 pit probably were insufficient to significantly reduce the high pressure gradient across the clay liner. Modeling of two hypothetical cross sections indicated that the use of a peripheral discharge system, and adequate underdrains on two of the clay liner, would reduce use of a peripheral discharge system, and adequate underdrains on top of the clay liner, would reduce the seepage from the pit. (See also W91-10018) (Author's abstract) W91-10043

FINANCIAL COMPUTER MODEL FO STORMWATER MANAGEMENT ANALYSIS. Georgia Inst. of Tech., Atlanta. For primary bibliographic entry see Field 6C. W91-10052

HYDROLOGY AND THE ENVIRONMENT: THE CASE STUDY OF SAO PAULO, BRAZIL. Sao Paulo Univ. (Brazii). Dept. de Hidraulica. For primary bibliographic entry see Field 6D. W91-10120

HYDROLOGY OF COASTAL LOWLANDS-ANALYSIS OF PROBLEMS AND RESEARCH NEEDS.

For primary bibliographic entry see Field 2A. W91-10124

INVOLVING HYDROLOGICAL RESEARCH IN LAND USE IMPROVEMENT.
Institutul de Meteorologie si Hidrologie, Bucharest

S. Blidaru, E. Dragoi, and V. Ceausescu.

IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 253-262, 10 fig, 2 tab, 2 ref.

Descriptors: \*Hydrologic models, \*Land management, \*Land use, \*Model studies, \*Optimum de-

velopment plans, \*Rainfall-runoff relationships, \*Water resources management, Groundwater movement, Hydrographs, Hydrologic data, Infiltration, Mathematical analysis, Rainfall intensity, Runoff coefficient, Slopes, Soil types, Surface flow, Turbidity, Vegetation effects.

The optimum use of land resources is a current The optimum use of land resources is a current problem of major importance. Essential to the solution of this problem is a knowledge of the water resources and hydrological research is, therefore, aimed at obtaining an understanding of the characteristics of water resources and the interdependence between the use of water resources and land use. An experimental determination of the relation-ship 'rainfall-infiltration-runoff' was employed for small surfaces (both for water and for sediments), small surfaces (both for water and for sediments), using a mobile uniform wetting device. It was found that under similar conditions of soil-type, slope, and rainfall intensity, the type of agriculture strongly influences the infiltration intensity. Under similar conditions of soil, vegetation cover, and rainfall intensity, turbidity increases with slope. With similar soil conditions, slope, and rainfall intensity, the value of maximum turbidity depends on the condition of the soil surface. Natural rainfall and surface and groundwater flow were correlated using experimental plots. It was found that the value of the maximum runoff coefficient decreases value of the maximum runor coefficient decreases with increasing slope length under the same rainfall conditions, slope, vegetation cover, and initial soil moisture. Rainfall-runoff models may be used to analyze the hydrologic effects of hydraulic structures. A physiographic type of model was adopted, which divides the basin into a finite number of maintaining coefficients. number of units with constant parameters. A runoff hydrograph was determined for each surface unit and then integrated for the entire basin. face unit and then integrated for the entire basin. Water balance components employed in the mathematical model were generally determined by experimental means. The analysis revealed that, excepting the rainfall, the most significant influence on runoff generation is infiltration, which is itself a function of the initial soil moisture, along with the roughness coefficient, surface storage, and interception. (See also W91-10103) (Fish-PTT) W91-10128

MODELLING THE INFLUENCE OF LAND USE CHANGE ON FLOOD FLOWS. Ruhr Univ., Bochum (Germany, F.R.). K. G. Richter, and G. A. Schultz. In: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International As-

sociation of Hydrological Sciences, Washington, DC. 1987. p 381-391, 7 fig. 3 tab. 10 ref.

Descriptors: \*Flood flow, \*Flood forecasting, \*Flood peak, \*Land use, \*Model studies, \*Rainfall-runoff relationships, \*Urbanization, Catchment areas, Flood plain management, Germany, Industrial development, Planning, Statistical analysis.

Man's activities, such as urbanization, industrialization, construction of roads and airports, have sig-nificant influences on the hydrological conditions in the river basins where they are undertaken. In particular, flood characteristics are usually altered flood peaks increase and there is a reduction in the time to peak. In Germany, planning procedures often demand that new flood conditions are quantified and protection measures (e.g. flood retention reservoirs) are likely changes in flood characteristics for the planned change in land use. Three reservoirs) are interly changes in flood characteris-tics for the planned change in land use. Three deterministic rainfall-runoff models were analyzed according to their capability to simulate such con-ditions. It was found that a distributed model was superior to two well known lumped models. Com-parison of the models' performance in three catchparison of the models' performance in three catchments having different degrees of industrialization shows promising results. In particular, the distributed model is able to quantify the expected changes in flood conditions depending on where within the catchments the planned activities are located. This is highly relevant for the planning process itself. (See also W91-10103) (Author's abstract) stract) W91-10138

INLET OF ALKALINE RIVER WATER INTO PEATY LOWLANDS: EFFECTS ON WATER

QUALITY AND STRATIOTES ALOIDES L.

QUALITI AND STRANDS.
STANDS.
Katholieke Univ. Nijmegen (Netherlands). Dept.
of Aquatic Ecology and Biogeology.
for primary bibliographic entry see Field 2H.
W91-10165

CHANGING IMPACT OF URBANIZATION AND MINING ON THE GEOLOGICAL ENVIRONMENT.

RONMENT.
Pretoria Univ. (South Africa). Dept. of Geology.
A. B. A. Brink, A. van Schalkwyk, T. C.
Partridge, D. C. Midgely, and J. M. Ball.
South African Journal of Science SAJSAR, Vol.
86, No. 7-10, p 434-440, July/October 1990. 3 fig, 2

Descriptors: \*Environmental effects, \*Groundwater pollution, \*Mining effects, \*Urbanization, \*Wastewater disposal, \*Wastewater treatment facilities, Developing countries, Environmental policy, Global warming, Leachates, Long-term planning, South Africa, Water resources management

Explosive population growth and rapid urbaniza-tion in many Third World countries, including South Africa, and increased exploitation of mineral resources on a global scale over the past three decades, have caused severe, and in many cases irreversible, changes to the geological environ-ment. Groundwater pollution may result from recharge by contaminated surface water, direct con-tact between wastes and the groundwater and seepage of leachates from a wastebody into the groundwater. Rapid population growth has placed an intolerable strain on existing water-borne sewage disposal facilities, and financial and other constraints largely preclude the provision of new services according to First World standards. South African scientists are in a unique position to study the mechanisms and to develop precautionary and remedial techniques which, if applied rigorously, should minimize future negative impact, despite increased population pressures and the local effects of global warming. Although most of the experience and solutions relate to local conditions, similar trends in urbanization and mining development and consequent environmental changes are likely and consequent environmental changes are likely to occur in most of the developing countries of the world. Through the application of established relationships, prediction of environmental impact on a global scale is considered feasible. (Brunone-PTT) W91-10189

SOCIO-ECONOMIC IMPACT OF DEVELOP-MENT SCHEMES IN THE 'HOMELANDS' OF

MENT SCHEMES IN THE HOMELANDS OF SOUTH AFRICA.

Rhodes Univ., Grahamstown (South Africa).
Dept. of Anthropology.
For primary bibliographic entry see Field 6B.
W91-10190

DIATOM, POLLEN, AND SEDIMENT MI-CROSTRATIGRAPHIC INVESTIGATIONS OF CROSTRATIGATHIC INVESTIGATIONS OF ANTHROPOGENIC EFFECTS ON LAKE HOELLER (UPPER AUSTRIA) (DIATOMEEN, POLLEN, AND SEDIMENTMIKROSTRATI-GRAPHISCHE UNTERSUCHUNGEN ZUR ANTHROPOGENEN BEEINFLUSSUNG DES HOELLER SEES (OBEROSTERREICH)). Akademie der Wissenschaften der DDR, B For primary bibliographic entry see Field 2H. W91-10216

#### 4D. Watershed Protection

MODELING THE CUMULATIVE WATER-SHED EFFECTS OF FOREST MANAGEMENT STRATEGIES.

Forest Service, Arcadia, CA. For primary bibliographic entry see Field 4C. W91-09332

PROBABILITY OF SEDIMENT YIELDS FROM SURFACE EROSION ON GRANITIC ROAD-FILLS IN IDAHO.

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# **Group 4D—Watershed Protection**

Intermountain Forest and Range Experiment Station, Boise, ID. For primary bibliographic entry see Field 2J. W91-09333

SEDIMENT TRANSPORT IN THE LOWER PUYALLUP, WHITE AND CARBON RIVERS OF WESTERN WASHINGTON.

Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 2J.

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME I: EROSION MODEL FOR DYNAMIC RILL NETWORKS, PART A-INTRODUCTION AND OVERVIEW, PART B-EROSION MODEL DEVELOPMENT.

Kentucky Univ., Lexington. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.

W91-09519

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME II: HYDROLOGIC MODEL FOR DYNAMIC RILL

Kentucky Univ., Lexington. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2J. W91-09520

HYDROLOGY AND SEDIMENTOLOGY OF DYNAMIC RILL NETWORKS, VOLUME III: SIMULATION OF RANDOM RILL NETWORK GEOMETRIES ON AGRICULTURAL SOILS. Kentucky Univ., Lexington. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2J. W91-09521

FOREST MANAGEMENT NONPOINT SOURCE RISK ASSESSMENT GEOGRAPHIC INFORMATION SYSTEMS APPLICATION. National Weather Service, Tulsa, OK. River Fore-

cast Center.

K. J. Lull, and D. F. Potts.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 23-30. 5 fig, 1 tab, 9 ref.

Descriptors: "Forest management, "Geographic information systems, "Land use, "Model studies, "Nonpoint pollution sources, "Risk assessment, "Watershed management, Computerized maps, Decision making, Erosion control, Slope degradation, Soil erosion, Technology transfer.

The map-based nonpoint source risk assessment and map-based nonpoint source risk assessment methodology developed by the State of Oregon for their 208 Assessment has been adapted for use with Geographic Information Systems (GIS). Central to the GIS application is a 'Leopold-type' risk matrix that has been developed concurrently. The orthogonal matrix displays combinations of forest properties of the control o orthogonal matrix displays combinations of forest management practices and classes of slope and soil erodibility. The relative nonpoint source risk for each matrix cell was assessed by experts using the Nominal Group technique. The cumulative effects analysis procedure was applied in Howard Creek on the Lolo National Forest which represents a heavily impacted mixed ownership watershed. A heavily impacted, mixed-ownership watershed. A risk index value was assigned for the watershed based on the areal extent of activities, the age of the treatments, and the type of terrain on which they are located. An undisturbed watershed would have a 0 risk index value. Results of the procedure revealed that, for data from 1986, the Howard Creek watershed was being stressed. However, recovery was rapid so the deferment of activities or the selection of low risk options would allow the cumulative risk value to fall, as indeed the cumulative risk value had fallen by 1990. (See also W91-09570) (Korn-PTT) W91-09573

DEVELOPMENT OF A WATERSHED MAN-

DEVELOPMENT OF A WATERSHED MAN-AGEMENT MODEL. CH2M Hill, Inc., Atlanta, GA. D. M. Wood, and R. L. Wycoff. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 281-291. 1 fig, 3 tab, 5 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Mathematical models, \*Model studies, \*Planning, \*Urban planning, \*Urban runoff, \*Watershed management, Decision making, Hydrologic simulation, Land development, Land use, Metropolitan water management, Pollution load, Soil types, Technology transfer, Water quality, Water supply, Yield equations.

The Mountain Island Lake watershed in Mecklen-The Mountain Island Lake watershed in Mecklen-burg County is the sole water source for the Char-lotte, North Carolina metropolitan area. The wa-tershed, largely undeveloped, is being pressured by development interests. A project was undertaken to aid County personnel in developing a lake wa-tershed protection plan. A model to predict water-shed yield and associated pollutant concentrations of development alternatives was developed and transferred to the County for use by its personnel. The procedure involved the use of yield curves derived from continuous hydrologic simulation to predict flow yield based on future Soil Conserva-tion Service (SCS) curve number (CN) values. In addition, regression equations, available through the National Urban Runoff Program (NURP), were used to predict pollution concentrations. The resulting flow yields and concentrations were then used to estimate pollutant loadings to the Lake as a used to estimate pointain losalings to the Lake as a result of increasing development. A simple receiv-ing water model was used to predict resulting ambient concentrations. With this procedure, County personnel could quickly and efficiently assess the impacts of different development scenar-ios. As a result, Mecklenburg County could pro-tect the future of its water supply by issuing zoning mandates founded on sound information. (See also W91-09570) (Korn-PTT)

APPLICATION OF HYDROLOGIC MODELS

TO RANGELANDS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7C.
W91-09718

# 5. WATER QUALITY MANAGEMENT AND PROTECTION

# 5A. Identification Of Pollutants

DETERMINATION OF TOTAL METALS IN SEWAGE SLUDGES BY ION CHROMATOG-

IGAPHY.

Iowa State Univ., Ames. Dept. of Agronomy.

N. T. Basta, and M. A. Tabatabai.

Journal of Environmental Quality JEVQAA, Vol.

20, No. 1, p. 79-88, January/March 1991. 7 fig. 5

tab. 29 ref. Iowa Agricultural Home Econ. Exp. Stn. Project 2710.

Descriptors: \*Analytical methods, \*Heavy metals, \*Ion exchange chromatography, \*Laboratory \*Ion exchange chromatography, \*Laboratory methods, \*Pollutant identification, \*Sludge analy sis, \*Wastewater treatment, Atomic absorption spectrophotometry, Cadmium, Copper, Lead, Manganese, Nickel, Sludge, Trace elements, Zinc.

An accurate and precise ion chromatographic (IC) method for the determination of total Cu, Mn, Ni, Pb and Zn was developed which consists of three steps: (1) digestion of the soil sample by using HNO3, HClO4, and HF; (2) extraction of the metals by using dithizone in CHCl3; and (3) destruction of the metal dithizonate complex with HNO3 and determination of the metals by IC. The It System consists of a guard (HPIC-CG5) column and separator (HPIC-CS5) column followed by post column reaction with 4-(-2-pyriylazo) resorcinol (PAR) to form colored metal complexes. The

absorbance of the metal PAR complexes was measured by a UV-VIS detector at 520 nm. Two differat eluents were required for separation of these tetals. The simultaneous determination of Cd, Cu, Mn, and Zn was achieved by using an eluent containing 4 mM 2,6-pyridinedicarboxylic acid and 50 mM HOAc-NaOAc buffer (pH 4.8). Simultane-50 mM HOAc-NaOAc butter (pH 4.8). Simultane-ous determination of Cu, Ni, Pb, and Zn was accomplished by using an eluent containing 40 mM oxalic acid and 50 mM HOAc-LiOAc buffer (pH 4.8). Results obtained by the IC method for several diverse sewage sludges were in good agreement with those obtained by atomic absorption spectrophotometry (AA). Results also showed that the proposed IC method is precise and has the same degree of precision as that of AA. Also, the sensitivity and detection limits of IC for these metals are similar to those of flame AA. (Author's ab-W91-09336

HYDRIDE GENERATION ATOMIC ABSORP-TION TECHNIQUE FOR ARSENIC SPECIA-TION.

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments. For primary bibliographic entry see Field 5B. W91-09338

IDENTIFICATION OF COPPER CONTAMINA-TION IN SEDIMENTS BY A MICROSCALE PARTIAL EXTRACTION TECHNIQUE.

Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.

K. Mesuere, R. E. Martin, and W. Fish. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 114-118, January/March 1991. 4 fig, 3 tab, 31 ref. Oregon Water Resources Research Inst. Project No. G1444-05.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Copper, \*Laboratory methods, Path of pollutants, Runoff, Sediment contamination, Sediments, Separation techniques, Surface detention.

Analysis of trace metals in sediments and soils Analysis of trace metals in sediments and soils commonly involves a partial chemical leaching procedure. Such an approach can be sound and useful if it reliably reveals anomalous trace metal concentrations in excess of the geochemical baseline. A H2O2/HNO3 microscale extraction procedure for the partial removal of metals from sediments beared on a modification of the formats. ments, based on a modification of the 'organic-sulfidic fraction' was performed on three sediments sulfide fraction was performed on three sediments taken from a detention pond receiving stormwater runoff from a parking lot. A previous study showed that a well defined plume of copper contaminated sediments was directly related to high levels of soluble and particulate Cu in the incoming runoff. The procedure is carried out at room temperature for approximately 24 hr, requires only 50 mg of dried sample, and 1mL of extraction solution for a single extraction, and results in a detection limit of 0.3 mg/kg dry sample. Since the release of small amounts of crystalline Cu, over time, reflects the mobilization of less labile mineral forms of Cu, it may not be related to anthropogenic pollution, and extraction time should not exceed 12-24 hr. Even though the most likely mineral and organic Even though the most likely mineral and organic phases of Cu were only partially removed, comparison with the commonly employed HCl extraction found the H202/HN03 method to be more reliable, especially with increasing levels of contamination. At low contamination levels, subtraction of a suitable background value becomes important [Only PUT]. portant. (Doyle-PTT) W91-09340

MEASUREMENT OF BIOAVAILABLE PHOS-PHORUS IN AGRICULTURAL RUNOFF. Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.

water Quanty and Watersned Research Lab.
A. N. Sharpley, W. W. Troeger, and S. J. Smith.
Journal of Environmental Quality JEVQAA, Vol.
20, No. 1, p 235-238, January/March 1991. 2 fig, 2
tab, 37 ref.

Descriptors: \*Agricultural runoff, \*Algal growth, \*Analytical techniques, \*Path of pollutants, \*Phos-

# Identification Of Pollutants—Group 5A

phorus, \*Water analysis, \*Water pollution sources, Aquatic productivity, Bioassay, Data acquisition, Eutrophication, Nutrients, Oklahoma, Sediments, Soil chemistry, Watersheds.

The role of soluble phosphorus which is immediately available for biological uptake is well known in accelerating biological productivity in surface waters receiving agricultural runoff. The role of sediment-bound or particulate P, however, can provide a long-term source of P for aquatic plant growth. It's role can be assessed if the biological availability of particulate P (PP) is known. Previous research has indicated the amounts of P extracted from deposited river and lake sediments by 0.1 M NaOH to be correlated with P untake by the 0.1 M NaOH to be correlated with P uptake by the alga Selenastrum capricornutum. A modification of this extraction was investigated to allow routine quantification of potentially bioavailable particulate P (BPP) content of agricultural runoff from the Reddish Prairies and Rolling Red Plains land resource areas. In the proposed method, 20 ml of unfiltered runoff is shaken with 180 ml of 0.11 M NaOH for 17 h and BPP concentration calculated NaOH for 17 h and BPP concentration calculated by subtraction of the soluble P (SP) concentration of the runoff sample. Total bioavailable P concentration (TBP) of runoff can be represented by BPP plus SP concentration. Growth of P-starved S. capricornutum, incubated for up to 29 d with runoff sediment from 9 watersheds, as the sole P source, was correlated (r-squared = 0.76 to 0.95) with potentially BPP content of the added sediment. Sample dilution had no effect on the amount of P extracted from runoff sediment by NaOH across a range in sediment concentration of the across a range in sediment concentration of the extraction medium, equivalent to that observed for 95% of the runoff events. If the sediment concentration of runoff exceeds 20 g/L, a smaller runoff sample is used in the extraction method to quantify the bioavailability of P transported in agricultural runoff. This extraction method provides an improved, interference free method to routinely determine the potential bioavailability of runoff P and its possible impact on biological productivity of surface waters. (Doyle-PTT)

EVALUATING WATER QUALITY IN THE LOUROS RIVER (GREECE) USING BIOTIC INDICES BASED ON INVERTEBRATE COMMU-

National Centre for Marine Research, Athens

For primary bibliographic entry see Field 5C. W91-09363

SHPOL'SKII FLUORIMETRY AS AN INDE-PENDENT IDENTIFICATION METHOD TO UPGRADE ROUTINE HPLC ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS. Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry. J. W. G. Mastenbroek, F. Ariese, C. Gooijer, N. H. Velthorst, and J. W. Hofstraat. Chemosphere CMSHAF, Vol. 21, No. 3, p 377-386, 1990. 5 fig, 1 tab, 3 ref.

Descriptors: \*Aromatic compounds, \*Chemical analysis, \*Fluorometry, \*High performance liquid chromatography, \*Pollutant identification, \*Polycuriomatography, "Folium I telemination," Foly-cyclic aromatic hydrocarbons, "Shpolskii spectros-copy, "Water analysis, Fluorescence, Fractiona-tion, High pressure liquid chromatography, Path of pollutants, Separation techniques, Spectroscopy.

Polycyclic aromatic hydrocarbons (PAHs) are among the most common pollutants of our envi-ronment, some of which are strongly carcinogenic and constitute a threat even at low concentrations. Thus it is important to identify their presence in air, food, water, soil, and other environmental sam-ples. A major analytical problem in the determina-tion of PAHs to date has been the separation of individual components in the presence of multiple isomers and alkylated compounds that have similar physical properties. In this study, marine sediment samples were taken from the Western Scheldt, southwest of the Netherlands, and the PAHs were determined with HPLC/fluoresence detection by a routine analysis developed at the Ministry of Transport and Public Works. Fractions of the

chromatogram were then further analyzed by an independent method, Shpol'skii spectroscopy, at the Free University of Amsterdam to ascertain the identity and purity of the HPLC peaks. Using this low temperature technique provided high resolution fluorescence spectra, peak purity, and a two-fold increase in the number of identified components. Shpol'skii fluorimetry is a valuable complementary method for improving routine HPLC analysis of PAHs. (D'Agostino-PTT) W91-09422

DETERMINATION OF STRONG MUTAGEN, 3-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE IN DRINKING

WALER IN JAPAN. Tokyo Univ. (Japan). Dept. of Urban Engineering. N. Suzuki, and J. Nakanishi. Chemosphere CMSHAF, Vol. 21, No. 3, p 387-392, 1990. 1 fig, 3 tab, 12 ref.

Descriptors: \*Chlorinated aromatic compounds, \*Drinking water, \*Mutagenicity, \*Mutagens, \*Pollutant identification, \*Water analysis, \*Water treatment, Ames test, Chemical mutagens, Chlorination, Japan, Organic compounds.

Although it is well known that positive Ames test mutagens are present in chlorinated tap water, the specific causative substances are not well identified. Recently, it has been shown that the strong mutagen, 3 chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) determined a substantial part of the TALO mutagraphy. 2(5H)-furanone (MX) determined a substantial part of the TA100 mutagenicity in both Finnish and U.S. tap water. In the present study, several tap water sources in Tokyo and Osaka, Japan were analyzed for the presence of this mutagen. The water samples contained 3 to 9 ng/L of MX, which accounted for 7 to 23% of the total observed TA100 mutagenicity. Future information on MX-related and non-MX responsible mutagens is necessary to complement these findings in order to suggest strategies for safer drinking water. (D'Agostino-PTT)

FLUORIDE-ALUMINIUM WATER CHEMISTRY IN FOREST ECOSYSTEMS OF CENTRAL

Goettingen Univ. (Germany, F.R.). Inst. fuer Bo-denkunde und Waldernaehrung. J. Ares.

Chemosphere CMSHAF, Vol. 21, No. 4/5, p 597-612, 1990. 4 fig, 4 tab, 25 ref.

Descriptors: \*Acid rain. \*Acid rain effects. \*Aluminum, "Europe, "Fluorides, "Forest ecosystems, "Path of pollutants, Fertilization, Forest hydrology, Hydrologic cycle, Minerals, Precipitation, Soil water. Thermodynamics.

Water is a dynamic environmental compartment which is significantly influenced by the influx, solubility, and chemical equilibria of various mineral pollutants. In the present study, the concentra-tion of the free and bound forms of fluoride (F) and aluminum (Al) were measured in several com-ponents of the water cycle at several forest ecosys-tem sites in central Europe which encompass a wide range of geographical and vegetation types and variable fertilization treatments. The concen-tration of Al and F forms in open land and stand precipitation and in soil water are highly predict-able on the basis of thermodynamic computations which take into account the speciation of these elements in acidic forms through the water cycle. Also, although organic ligands which are also present can trap a considerable amount of Al, in most cases this does not modify the measurement of ALF complexes to a significant extent. (D'Agostion PTT) tino-PTT) W91-09432

CATCHMENT SURVEY FOR HEAVY METALS USING THE EEL (ANGUILLA ANGUILLA). Essex Univ., Colchester (England). Dept. of Biol-

ogy. C. F. Mason, and N. A. E. Barak. Chemosphere CMSHAF, Vol. 21, No. 4/5, p 695-699, 1990. 1 fig, 2 tab, 10 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Eel, \*Heavy metals, \*Path of pollutants, \*Rivers, \*Toxicity, \*Trace elements, Cadmium, Drainage basins, England, Lead, Mercury, Surveys.

The monitoring in water of heavy metals, such as Hg, Cd, and Pb, is currently mandatory because of their toxic potential and ability to accumulate in food chains. Furthermore, rivers in which these metals are below the limit of detection for aqueous samples may nevertheless contain fish with high accumulated metal concentrations. Study of eels in awaters draining into the Colne/Blackwater esta-ary, in Essex, eastern England indicated that the fish (n=319) at 26% of the 57 examined sites had hish (n=319) at 26% of the 57 examined sites had fig concentrations above the recommended levels for human consumption. Hg, Cd, and Pb concentrations were generally correlated and elevated levels were predominantly found around sewage discharges. Eels (Anguilla anguilla) appear to be better indicators than water samples for detecting heavy metal pollution of fresh water ecosystems. (D'Agostino-PTT) W91\_09434

DETECTION OF GIARDIA CYSTS WITH A CDNA PROBE AND APPLICATIONS TO WATER SAMPLES.

Arizona Univ., Tucson. Dept. of Nutrition and Food Science.

M. Abbaszadegan, C. P. Gerba, and J. B. Rose. Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 927-931, April 1991. 1 fig, 4 tab, 19 ref.

Descriptors: \*Giardia, \*Monitoring, \*Nucleic acids, \*Parasites, \*Pollutant identification, \*Wastewater analysis, \*Water analysis, DNA, Diseases, Fluorescence, Human diseases, Immunoassay, Protozoa, Public health, RNA, Sample prepa-

The efficacy of a single-gene probe was evaluated for the detection of Giardia species in water. A cDNA probe, 265 bp long, from the small subunit of rRNA of G. lamblia was used for detection of cysts. The replicative form of the M13 vector with an insert was isolated from lysed host Escherichia an insert was some from your not coli XLI-Blue and used for production of the cDNA probe by nick translation with P32-labeled nucleotides. Six different protocols were tested for extracting nucleic acids from the cysts. With the most efficient procedure, disrupting Giardia cysts with glass beads in the presence of proteinase K, as with gass beads in the presence or proteinase k, as few as 1 to 5 cysts per ml can be detected in water sample concentrates with dot blot hybridization assays. The use of a ribosomal cDNA probe makes it possible to detect the low numbers of Giardia. cysts that are commonly found in water because of the high copy number of rRNA in each of the two trophozoites per cyst. This method appears compa-rable to the immunofluorescence system for cyst detection in environmental samples. Although nei-ther the cDNA probe nor the immunofluorescence system can be used to determine cyst viability, it may be feasible to develop gene-specific probes for the routine monitoring of Giardia cyst contamination in water supplies, particularly as nonradioactive labels are developed for nucleic acid probes. (Doria-PTT) W91-09442

DETECTION OF ESCHERICHIA COLI AND SHIGELLA SPP. IN WATER BY USING THE POLYMERASE CHAIN REACTION AND GENE PROBES FOR UID.

Louisville Univ., KY. Dept. of Biology. A. K. Bej, J. L. DiCesare, L. Haff, and R. M. Atlas

Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 1013-1017, April 1991. 4 fig. 14 ref.

Descriptors: \*Bacterial analysis, \*Bioindicators, \*Escherichia coli, \*Fecal bacteria, \*Nucleic acids, \*Pollutant identification, \*Polymerase chain reaction, \*Shigella, \*Water quality monitoring, Coliforms, Enteric bacteria, Enzymes, Fluorescence, Genetics, Microbiological studies, Water analysis.

# Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

# Group 5A—Identification Of Pollutants

The Colilert test, when used to detect Escherichia coli in water, is based on detecting beta-D-glucu-ronidase activity, using enzymatic transformation of the fluorogenic substrate 4-methylumbelliferyl-beta-glucuronidide (MUG). A method for detectbeta-glucuronidate (MOO). A method for detecting E. coli was developed that uses the polymerase chain reaction (PCR) and gene probes, based on amplifying regions of the uid gene that code for beta-glucuronidase. Amplification and gene probe detection of four different regions of uid specifically detected E. coli and Shigella species including beta-glucuronidase-negative strains of E. coli. No amplification was observed for other coliform and nonenteric bacteria. Thus, this gene probe detection may overcome the potential problem of the Colilert system, that is, the failure to detect MUGnegative strains, which may constitute 30% of the fecal coliform bacteria in some water sources. Multiplex PCR amplification of lacZ for total coliforms and uidA or uidR for fecal coliforms and the torms and utor or utors for tecar conforms and the development of a nonisotopic gene probe detection technique, such as immobilized capture probes, can permit a rapid and reliable means of assessing the bacteriological safety of water and should provide an effective alternative to the conventional viable culture methods. (Doria-PTT) W91-09444

RAPID METHOD FOR DIRECT EXTRACTION OF DNA FROM SOIL AND SEDIMENTS.

California Univ., Irvine. Program in Social Ecolo-

Y. L. Tsai, and B. H. Olson.

Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 1070-1074, April 1991. 5 fig, 1 tab, 25 ref. EPRI Grant 8000-25.

Descriptors: \*Bacterial analysis, \*DNA, \*Pollutant identification, \*Sampling, \*Sediment sampling, \*Soil organisms, California, Chloroform, Enzymes, Freezing, Microorganisms, Nucleic acids, Oak Ridge, Phenols, Sediments, Settling basins, Solvents, Tennessee, Thawing.

A rapid method was developed for the direct extraction of bacterial DNA and applied to soil samples from a site in Southern California and to samples from a site in Southern California and to sediment samples from a settling pond in Oak Ridge, Tennessee. The indigenous microorganisms in the soil and sediments were lysed using lysozyme and a freeze-thaw procedure. The lysate was extracted with sodium dodecyl sulfate and phenolchloroform. In addition to a high recovery efficiency (>90%), the yields of DNA were high (38 and 12 micrograms/g wet weight from sediments and soil, respectively). This method generated minimal shearing of the extracted DNA. The crude DNA could be purified further with an Elutip-d column if necessary. An additional advantage of this method is that only 1 g of sample is tage of this method is that only 1 g of sample is required, which allows for the analysis of small samples and the processing of many samples in a relatively short (7 h) period. The method can detect the presence of a target gene such as merA from a minimum of 5,000 bacterial cells. The high yield in combination with the high quality of DNA will enable microbial ecologists to study DNA companies of the processing of the processing the processing of from environmental samples in a more detailed fashion by molecular biology techniques. (Doria-PTT) W91-09445

DEVELOPMENT AND APPLICATION OF NEW POSITIVELY CHARGED FILTERS FOR RECOVERY OF BACTERIOPHAGES FROM

Malaga Univ. (Spain). Dept. of Microbiology. J. J. Borrego, R. Cornax, D. R. Preston, S. R. Farrah, and B. McElhaney.

Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 1218-1222, April 1991. 3 tab, 26 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Electrochemistry, \*Filtration, \*Isolation, \*Pollut-ant identification, \*Sampling, \*Wastewater analy-sis, Adsorption, Cations, Diatomaceous earth, Disinfection, Enteroviruses, Polymers, Reagents, Sample preparation, Viruses, Water quality moni-

Bacteriophage can serve as models or indicators for the removal or inactivation of enteroviruses in wastewater treatment. Electronegative and elec-tropositive filters were compared for the recovery tropositive inters were compared to it necessary of indigenous bacteriophage from water samples, using the VIRADEL (virus adsorption and elution) technique. Fiber glass and distornaceous earth filters displayed low adsorption and recovery, but an important increase in adsorption percentage was seen when the filters were treated with cationic polymers (about 99% adsorption). A new method of virus elution was developed, consisting of the slow passage of the eluent through the filter, thus slow passage of the eluent through the filter, thus increasing the contact time between eluent and virus adsorbed on the filters. This technique allows a maximum recovery of 71.2% compared with 46.7% phage recovery obtained by the standard elution procedure. High percentages (over 83%) of phage adsorption were obtained with different filters from 1-liter aliquots of the samples, except for Virosorb 1-MDS filters (between 1.6 and 32% phage adsorption). Phage recovery by the slow passage of the eluent depended on the filter type, with recovery ranging from 1.6% for Virosorb 1-MDS filters treated with polyethyleneimine to 103.2% for diatomaceous earth filters treated with 0.1% Nalco. (Author's abstract) W91-09449

ENZYME IMMUNOASSAY FOR IDENTIFICATION OF VIBRIO VULNIFICUS IN SEAWATER, SEDIMENT, AND OYSTERS.
Food and Drug Administration, Dauphin Island,
AL. Fishery Research Branch.
M. L. Tamplin, A. L. Martin, A. D. Ruple, D. W.
Cook, and C. W. Kaspar.
Applied and Environmental Microbiology
AEMIDF, Vol. 57, No. 4, p 1235-1240, April 1991.
4 fig, 4 tab, 27 ref. NOAA Contract NA89WC-HSK032.

Descriptors: \*Bacterial analysis, \*Immunoassay, \*Marine sediments, \*Oysters, \*Pathogenic bacteria, \*Pollutant identification, \*Seawater, \*Vibrio, "Name ia, "Pollutant identification, "Seawater, "VIDID, "Water analysis, Bacterial physiology, Culturing techniques, Detection limits, Electron microscopy, Enzymes, Isolation, Mollusks, Sediment contamination, Statistical analysis, Temperature, Tissue

Historically, methods used to identify Vibrio vulnificus in environmental samples have been inad-equate because isolation and identification procedures are time-consuming and fail to separate V. vulnificus from other bacterial species. An enzyme immunoassay (EIA) and culture techniques were used to identify V. vulnificus in seawater, sediment, and oysters. The EIA used monoclonal antiment, and oysters. The EIA used monoclonal anti-body FRBT37 to a species-specific epitope of V. vulnificus. No cross-reactions were observed among 72 non-V. vulnificus strains comprising 34 species and 15 genera. In field trials, the EIA correctly identified 99.7% of 348 biochemically confirmed V. vulnificus isolates. The epitope cor-responding to FRBT37 was found in cells lysed by Triton X-100, deionized H20, and ultrasonication but was not found in culture superastants indicat-Triton X-100, deionized H20, and ultrasonication but was not found in culture supernatants, indicating that its location was intracellular. In addition, electron micrographs of V. vulnificus labeled with FRBT37-biotin-avidin-gold showed that epitope FRBT37 reacted with fragments of lysed cells but not with whole cells. FRBT37 was expressed when V. vulnificus was cultured in different growth media. The minimum level of detection of the EIA was approximately 2,000 cells per EIA well. Epitope FRBT37 was labile at 70 C for 30 min. Immunoblot and EIA plate formats reduced assay time and facilitated handling large numbers assay time and facilitated handling large numbers of test samples. (Author's abstract)
W91-09450

GUIDELINES FOR COLLECTION AND FIELD ANALYSIS OF WATER QUALITY SAMPLES FROM STREAMS IN TEXAS.
Massachusetts Inst. of Tech., Cambridge. Micro-

For primary bibliographic entry see Field 7B. W91-09481

AILABILITY AND SUITABILITY OF MU-CIPAL WASTEWATER INFORMATION

FOR USE IN A NATIONAL WATER-QUALITY ASSESSMENT: A CASE STUDY OF THE UPPER ILLINOIS RIVER BASIN IN ILLINOIS, INDIANA, AND WISCONSIN.

Geological Survey, Urbana, IL. Water Resources

J. S. Zogorski, S. F. Blanchard, R. D. Romack, and F. A. Fitzpatrick.

and F. A. Fitzpatrick. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-375, 1990. 74p, 3 fig, 27 tab, 12 ref.

Descriptors: \*Effluents, \*Municipal wastewater, \*Wastewater facilities, \*Water quality, Pollutants, Pollution load, Water quality management.

The availability and suitability of existing information on municipal wastewater-treatment practices and effluent characteristics for use in a national water-quality assessment were evaluated. The in-formation will be used to determine the effects of changes in wastewater-treatment practices on stream quality and ecosystem health. A large stream quality and ecosystem health. A large amount of information on treatment practices and effluent characteristics exists, and some of this information is available from Federal and State computer data bases. However, the suitability of existing information to accomplish the objectives of a national water-quality assessment is limited. The suitability of this information would be improved by (1) increasing the number of water-quality constituents routingly analyzed for in second quality constituents routinely analyzed for in sam-ples of municipal effluent, (2) increasing the frepies of influency aerinden, (2) increasing the requency of effluent sampling at some facilities, (3) developing a quality-assurance plan for wastewater flow-rate determinates, and (4) increasing the amount of effluent water-quality data entered into Federal and State computer data bases. (USGS)

CHEMICAL STABILITY OF WET-DEPOSITION SAMPLES SUBSAMPLED DAILY FOR ONE WEEK.

Geological Survey, Denver, CO. Water Resources

For primary bibliographic entry see Field 7B.

RESULTS OF TEST DRILLING IN HOWELL TOWNSHIP, MONMOUTH COUNTY, NEW JERSEY.

Geological Survey, Trenton, NJ. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09528

BIOASSAY PROCEDURE FOR PREDICTING COLIFORM BACTERIAL GROWTH IN DRINKING WATER.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. E. W. Rice, P. V. Scarpino, G. S. Logsdon, D. J. Reasoner, and P. J. Mason.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 821-828, 1990. 5 tab, 9 ref.

Descriptors: \*Bioassay, \*Coliforms, \*Drinking water, \*Pathogenic bacteria, Bacteria, Culturing techniques, Testing procedures, Total organic carbon, Water quality.

Bacterial growth in drinking water is an area of growing awareness and significant concern for many water utilities. To date, procedures develmany water utilities. To date, procedures developed for measuring the amount of biodegradable material, which provide the supply of assimilable nutrients, present in potable water have utilized heterotrophic non-coliform bacteria as bioassay seed organisms. None are specifically designed to measure nutrient levels which will support the growth of coliform organisms, some of which are opportunistic pathogens. A specific bioassay for determining the ability of water to support and promote the growth of coliform bacteria was de-veloped. Three different coliform organisms were utilized: Escherichia coli, Enterobacter cloacae, and Klebsiella oxytoca. Experiments were conducted to evaluate the use of membrane filtration

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

# Identification Of Pollutants—Group 5A

for the removal of the indigenous microfloral population from the test waters, and to determine an appropriate incubation temperature for the bioasay. Growth responses indicated that ozonation increased the availability of nutrients, and chlorination increased the nutrients in some cases. The method is potentially useful for evaluating the effect of various unit processes on the biological stability of water. (D'Agostino-PTT) W91-09659

TRACE ORGANICS DETERMINATION IN DRINKING AND SURFACE WATERS, Venice Univ. (Italy). Dept. of Environmental Sci-

L. Szpyrkowicz, J. Naumeczyk, and F. Z. Grand. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 927-934, 1990. 1 fig, 2 tab, 12 ref.

Descriptors: \*Drinking water, \*Organic compounds, \*Organic pollutants, \*Pollutant identification, \*Separation techniques, \*Surface water, \*Water analysis, Adsorption-desorption, Aliphatic hydrocarbons, Chlorinated hydrocarbons, Dichloromethane, Gas chromatography, Humic substances, Mass spectrometry, Phthalates.

Improvement in chromatographic separation and identification techniques has greatly enhanced the conventional methods of pollutant determination in drinking and surface waters. Trace organic comdrinking and surface waters. Trace organic compounds in samples from river, lake, and drinking water were separated by two adsorption/desorption methods: an anionic resin with Nacl/NaOH, and a nonionic resin with Michloromethane (DCM). The DCM extract was further fractionated and analyzed by a combination of gas chromatography and mass spectroscopy (GC-MS). Humic substances comprised the largest organic fraction of water contaminants. Aliphatic hydrocarbons and phtalates predominated in the DCM extracts. Fractions containing hexane. CCI4, benzene, chlo-Fractions containing hexane, CCl4, benzene, chlo-roform, and organic bases were also identified which provided an approximate indicator of the extent of pollution in a specific water source. (D'Agostino-PTT) W91-09669

CLOSED FLOW-THROUGH AQUATIC TOXIC-ITY TESTING AND MICROSCOPIC ORGANISMS: NOT NECESSARILY INCOMPATIBLE. California Univ., Santa Cruz. Inst. of Marin ences.

For primary bibliographic entry see Field 5C. W91-09756

FIELD ASSESSMENT OF BIOMARKERS FOR WINTER FLOUNDER.

Battelle Ocean Sciences, Duxbury, MA. For primary bibliographic entry see Field 5C. W91-09757

RELATIONSHIPS BETWEEN HEAVY METAL CONTENT AND BODY WEIGHT OF FISH FROM THE KELANG ESTUARY, MALAYSIA. Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science. For primary bibliographic entry see Field 5B. W91-09763

OCCURRENCE OF CYPRINIDAE AND OTHER SMALL FISH SPECIES IN RELATION TO PH IN ONTARIO LAKES.
Ontario Ministry of Natural Resources, Toronto.

For primary bibliographic entry see Field 5C. W91-09765

GROUNDWATER QUALITY ASSESSMENT THROUGH COOPERATIVE PRIVATE WELL TESTING: AN OHIO EXAMPLE. Heidelberg Coll., Tiffin, OH. Water Quality Lab. D. B. Baker.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 230-235, 1990. 11 ref.

Descriptors: \*Groundwater quality, \*Monitoring, \*Ohio, \*Public participation, \*Water analysis,

\*Water quality monitoring, \*Water sampling, \*Well water, Agricultural chemicals, Data collections, Fertilizers, Nitrates, Test wells, Water

In 1987, a cooperative private water supply testing program was initiated in Ohio. Since that time, 80 of holio's 88 counties have participated in the program. In each county, such local organizations as soil and water conservation districts, extension agencies and Farm. Bureau groups spongered a as soil and water conservation districts, extension agencies and Farm Bureau groups sponsored a countywide sampling program. The local groups advertised the program, arranged for the distribution of sampling kits, established a countywide collection date, set up a sample collection station and prepared a map showing the locations of well samples from that county. This testing program has provided a useful 'snapshot' of the status of nitrate contamination in Ohio's private water supplies (Feder,PTT) plies. (Feder-PTT) W91-09879

AGRICULTURAL CHEMICALS IN GROUND-WATER: MONITORING AND MANAGEMENT IN CALIFORNIA.

California Univ., Los Angeles. School of Public Affairs.

For primary bibliographic entry see Field 5G. W91-09885

ACCUMULATION OF METAL RADIO-TRACERS BY MYTILUS EDULIS.
International Lab. of Marine Radioactivity,
Monaco-Ville (Monaco).
C. Nolan, and H. Dahlgaard.
Marine Ecology Progress Series MESEDT, Vol.
70, No. 2, p 165-174, 1991. 3 fig, 4 tab, 41 ref.

Descriptors: \*Mollusks, \*Heavy metals, \*Bioaccumulation, \*Mediterranean, \*Radioactive tracers, \*Sea mussels, \*Bioindicators, Water pollution, Cobalt, Zinc, Ruthenium, Cesium, Silver, Salinity, Temperature, \*Estuarine environment.

Edible mussels, M. edulis, have been widely used in marine monitoring programs as indicators of pollution. The accumulation of cobalt, zinc, ruthenium, cesium and silver radiotracers in M. edulis under Mediterranean conditions was studied. The effect of organism size on uptake was examined and the results were compared with those of ex-periments performed previously at lower salinities and temperatures. These radiotracers accumulated and temperatures. These radiotracers accumulated in the soft tissues of this mussel linearly over time during exposure periods of up to 9 days. Radiotracer binding to shell was rapid, but variable, and was essentially complete after 1 day. The distribution between soft tissues and shell varied with each metal and exposure period, and ranged from 1:25 for cesium and silver to 1:1 for cobalt after 9 days. Radiotracer contents of all isotopes in the mussels were lognormally distributed. Radionuclide contents after exposure increased with shell length and are best described by nower functions of body are best described by power functions of body weight. After 9 days of exposure both ruthenium and silver exhibited a typical surface-type behav-ior, where the metal content of the mussels is proportional to their surface area. By contrast, cobalt, zinc and cesium exhibited a metabolic-type cooait, zinc and cesume atmotted a metaconci-type behavior. Since uptake is size-dependent, care must be taken in sampling programs to restrict the size ranges sampled and to collect sufficient numbers of individuals if significant changes in metal content are to be identified. Accumulation is slower under Mediterranean conditions than at the lower salinities encountered in the Baltic Sea and in estuarine environments. (Medina-PTT) W91-09928

EFFECT OF ORGANIC FERTILIZERS ON MI-CROFLORA OF A POLLUTED SOIL. Belorussian Academy of Sciences, Minsk. Inst. of Microbiology. For primary bibliographic entry see Field 5C. W91-09948

THEORETICAL FOUNDATIONS OF BIOINDI-CATION: I, CONCEPTUALIZATION OF SOME PROBLEMS.

Adam Mickiewicz Univ., Poznan (Poland). Dept. of Geobotany.

P. Szmajda.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 67-72, 1990. 2 fig,

Descriptors: \*Bioindicators, \*Model studies, \*Pollutant identification, \*Water pollution effects, Theoretical analysis.

The theoretical foundation of bioindication is based on two essential definitions: (1) bioindication is the determination of the state of the environment or intensity of environmental factors (pollutants) by means of appropriate standard taxa (bioindica-tors); and (2) a bioindicator is any species whose presence (or absence) indicates the occurrence, in a given place and time, of a certain type of strictly determined ecological factor(s) of a strictly deterdetermined ecological factors) of a strictly determined, and fitting within a narrow interval, intensity or of the proper threshold value. A typological model relates the classification of indicators of the state of the biocenosis to the physical and chemical properties of the environment, these properties being of either natural or anthrongenic origin. being of either natural or anthropogenic origin. Distinguishing of bioindicators must be closely as-Distinguishing of boundations has to ecological optima of a species. Two categories of autecological optima have been distinguished: physiological and ecological. Based on the idealization method of science, a theoretical reconstruction of the autecological optimum of a species and factors which condition it can be performed. The assignation of the proper hierarchy of ecological factors is also important in a theoretical study of bioindication. In the light of the method of idealization, an essential hierarchy can be distinguished in an ecological study, based on the differentiation of the degree of significance of the influence on species and domi-nance hierarchy; the dominance hierarchy refers to the statistically determined intensity of the effect of particular factors observed in a given place and time. (Sand-PTT) W91-09986

ASSESSMENT OF THE PISCINE MICRONU-CLEUS TEST AS AN IN SITU BIOLOGICAL INDICATOR OF CHEMICAL CONTAMINANT

National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center.

K. R. Carrasco, K. L. Tilbury, and M. S. Myers. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2123-2136, November 1990. 7 fig, 5 tab, 78 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*California, \*Croakers, \*In situ tests, \*Laboratory methods, \*Path of pollutants, \*Piscine micronucleus test, \*Water pollution effects, Bile, Fish pathology, Lesions, Literature review, Liver, Marine pollution, Tiesus analysis. tion. Tissue analysis.

The piscine micronucleus test was assessed for sensitivity and practicality as an in situ biological indicator of chemical contaminant exposure by an application to the peripheral blood of wild white croaker (Genyonemus lineatus) collected from pol-luted and reference areas along the California coast. Several types of variations from the usual erythrocyte nuclear morphology were observed in the blood smears collected for this study and the frequencies were compared with measured levels of certain classes of contaminants in white croaker bile and liver, and in sediment collected at each site. In addition, the frequencies were also com-pared with the prevalence of idiopathic lesions in the livers of the croaker. However, the piscine micronucleus test appeared to lack sensitivity to the presence and effects of the measured contaminants because no association was detected between the frequencies of the erythrocyte nuclear variations and levels of chemical contamination, even though most of the observed variations resembled published descriptions of variations presumed to be nuclear lesions would present a serious difficulty to the useful application of the test. The piscine mi-cronucleus test was found to be of highly question-able value as an in situ indicator of biological

# **Group 5A—Identification Of Pollutants**

effects in wild fish exposed to the chemical con-taminants measured. (Author's abstract) W91-09994

USEPA METHOD STUDY 35, SW METHOD 3005, ACID DIGESTION OF WATERS FOR TOTAL RECOVERABLE OR DISSOLVED METALS FOR ANALYSES BY FLAME ATOMIC ABSORPTION SPECTROSCOPY.

Bionetics Corp., Cincinnati, OH.
For primary bibliographic entry see Field 7B. W91-10081

EFFECT OF CHRONIC TOXICITY OF COPPER ON THE ACTIVITY OF BALBIANI RINGS AND NUCLEOLAR ORGANIZING REGION IN THE SALIVARY GLAND CHROMOSOMES OF CHIRONOMUS NINEVAH

Mosul Univ. (Iraq). Dept. of Biology. For primary bibliographic entry see Field 5C. W91-10204

ACCELERATION OF CATALASE AND PER-OXIDASE ACTIVITIES IN LEMNA MINOR L. AND ALLIUM CEPA L. IN RESPONSE TO LOW LEVELS OF AQUATIC MERCURY. Berhampur Univ. (India). Dept. of Botany. For primary bibliographic entry see Field 5C. W91-10205

DISTRIBUTION OF SELECTED HEAVY METALS IN SKIN AND MUSCLE OF FIVE TROPICAL MARINE FISHES,

University of the West Indies, St. Augustine (Trinidad and Tobago). Dept. of Chemistry.
For primary bibliographic entry see Field 5B. W91-10208

SUNLIGHT AND THE SURVIVAL OF ENTER-IC BACTERIA IN NATURAL WATERS

Newcastle upon Tyne Univ. (England). Dept. of

Newcastle upon Tyne Univ. (Engania). Dept. of Civil Engineering. C. M. Davies, and L. M. Evison.

Journal of Applied Bacteriology JABAA4, Vol. 70, No. 3, p 265-274, March 1991. 5 fig, 4 tab, 21

Descriptors: \*Bioindicators. \*Enteric bacteria. \*Escherichia coli, \*Microbiological studies, \*Path-ogenic bacteria, \*Salmonella, Bacterial growth, Freshwater, Humic acids, Salinity, Seawater, Solar radiation. Ultraviolet radiation.

Escherichia coli and some salmonellas were exposed in seawater and freshwater to natural sunlight, visible light of comparable intensity, and light containing a similar proportion of UV as natural sunlight but of a much lower intensity. Direct viable bacterial counts and culturable counts on selective and non-selective media were made at intervals. The rate of decrease in numbers of culturable bacteria was significantly faster in seawater than in freshwater when exposed to natu-ral sunlight. No significant difference was found between the rates of decrease in numbers of culturable bacteria in seawater and those in freshwater when bacteria were exposed to light with a small UV component of similar intensity. The effect of salinity on loss of culturability is, therefore, more significant in the presence of UV radiation. Direct counts by the acridine orange direct viable count method decreased much more slowly than the culturable counts in seawater but comparably with culturable counts in freshwater in natural sunlight. Direct viable counts and culturable counts de-creased at a similar rate in seawater and in freshwater in visible light. This may signify the evolu-tion of enteric bacteria towards a viable but nonculturable form in seawater when exposed to natural sunlight. The presence of humic acids signifi-cantly reduced loss of culturability but only in low salinity conditions. Salinity appears to be an impor-tant factor influencing culturability in bacteria ex-posed to sunlight. (Author's abstract) W91-10212

SGAP-10C AGAR FOR THE ISOLATION AND QUANTIFICATION OF AEROMONAS FROM WATER. Aigues de Barcelona (Spain). J. M. Huguet, and F. Ribas. Journal of Applied Bacteriology JABAA4, Vol. 70, No. 1, p 81-88, January 1991. 5 fig, 6 tab, 18 ref.

Descriptors: \*Agars, \*Bacterial analysis, \*Microbiological studies, \*Pathogenic bacteria, \*Water analysis, Aeromonas, Culturing techniques, Laborator, methods. Pseudomonas, Vibrio. ratory methods, Pseudomonas.

Glutamate starch penicillin (GSP) medium was used for the simultaneous isolation of Pseudomonas and Aeromonas. Modifications were made to and Aeromonas. Modifications were made to reduce the number of Pseudomonas and background flora and to improve the recovery of Aeromonas from water samples. The original medium was modified by adding glucose and ampicillin. The addition of 10 microgram/L of C-glucose to the medium (SGAP-10C) permitted better recuperation of trees deally 6 recomposed and the apprication of trees deally 6. ation of stressed cells of aeromonads and the ampi-cillin reduced the numbers of Pseudomonas. The clim reduced the numbers of resetuomass. In the best temperature for the recovery of aquatic aeromonads was 28 C. The recovery of different species of Aeromonas on SGAP-10C was 93%. The selectivity of the medium was validated because 95.5% of 28 colonies tested with an Aeromonas-93.5% of 28 colones tested with an Aeromonas-like morphology belonged to the genus Aero-monas. Moreover, when 45 strains of different genera were cultured on the medium, only Vibrio alginolyticus presented a confusing morphology. When the SGAP-10C was compared with GSP with 45 river samples, the new medium gave a significantly better recovery of Aeromonas species, especially when large numbers of Pseudomonas were present. SGAP-10C used at 28 C and 48 h was an efficient selective medium for the isolation of Aeromonas from fresh waters. (Author's abstract) W91-10230

MEMBRANE FILTER PROCEDURE FOR AS-SAYING CYTOTOXIC ACTIVITY IN HETERO-TROPHIC BACTERIA ISOLATED FROM DRINKING WATER. Environmental Monitoring Systems Lab., Cincin-nati OH.

nati, OH.

D. J. Lye, and A. P. Dufour.

Journal of Applied Bacteriology JABAA4, Vol.

70, No. 1, p 89-94, January 1991. 4 tab, 12 ref.

Descriptors: \*Bacterial analysis, \*Cytotoxicity assay, \*Drinking water, \*Heterotrophic bacteria, \*Membrane filters, \*Microbiological studies, \*Pathogenic bacteria, \*Water analysis, Aeromonas, Escherichia coli, Legionella, Vibrio.

Cytotoxic activity assays of Gram-negative, hetercytotoxic activity assays of tram-negative, neter-otrophic bacteria are often laborious and time con-suming. In situ procedures for testing potential cytotoxic activities of heterotrophic bacteria isolat-ed from drinking water systems were investigated. Water samples were passed through 0.45-micron membrane filters which were then placed upon appropriate media and incubated. After incubation. each membrane filter was transferred to the surface of Y-1 mouse adrenal cells overlaid with 1% agar. The filters were removed after exposure for 15 min. The cells were then incubated at 37 C in 2.5% CO2 for an additional 24 h. The release of cyto-toxic and cytotonic products from the bacterial colonies was recognized by zones of cellular lysis and injury of Y-1 cells that appeared immediately and injury of Y-1 cells that appeared immediately beneath the membrane. Cytotoxic strains of Aeromonas, Vibrio, Escherichia, and Legionella species were readily recognized by this method. About 1% of the bacteria isolated from drinking water also released cytotoxic products. This frequency was dependent upon the primary medium used and the density of bacteria present. The majority of cytotoxic strains isolated from drinking water also expressed protease activity (95%) and hemolytic activity (70%). This in situ membrane filter procedure is a facile method for simultaneously testing many different bacterial colonies. (Author's abstract) stract) W91-10231

TRACE ELEMENT ANALYSIS OF WATER USING RADIOISOTOPE INDUCED X-RAY

FLUORESCENCE (CD-109) AND A PRECON-CENTRATION-INTERNAL STANDARD METHOD (MEDIDA DE ELEMENTOS META-LICOS A NIVEL DE TRAZAS EN AGUAS POR MEDIO DE FLUORESCENCIA DE RAYOS X CON RADIOISOTOPOS (CD-109) UTILI-ZANDO UN METODO DE PRECONCENTRA-CION Y ESTANDARIZACION INTERNA).

Universidad Nacional Pedro Henriquez Urena, Santo Domingo (Dominican Republic). Dept. de

M. Alvarez, and W. Cano.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-704266. Price codes: A03 in paper copy, A01 in microfiche. Report No. INIS-mf-11284, 1986. 15p, 6 fig. 5 tab,

Descriptors: \*Cadmium radioisotopes, \*Laboratory methods, \*Pollutant identification, \*Trace elements, \*Water analysis, \*X-ray fluorescence, Chemical analysis, Chemical precipitation, Cobalt, Copper, Data acquisition, Heavy metals, Iron, Lead, Mercury, Nickel, Zinc.

Radioisotope induced X-ray fluorescence using 109-Cd was used for the determination of iron, nickel, copper, zinc, lead and mercury in water. These metals were concentrated by precipitation with the chelating agent APDC. The precipitated form was filtered using a membrane filter. Cobalt was added as an internal standard. Minimum detection limit, sensitivities and calibration curve lineari-ties have been obtained to find the limits of the method. The usefulness of the method was illustrated analyzing synthetic standard solutions. As an application, analytical results are given for water of a highly polluted river water. (Author's abstract) W91-10249

HAZARDOUS WASTE SITE CHARACTERIZA TION UTILIZING IN SITU AND LABORATORY BIOASSESSMENT METHODS.

Corvallis Environmental Research Lab., OR

L. Kapustka, and G. Linder.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134222. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/215, 1989. 18p, 3 fig, 3

Descriptors: \*Data acquisition, \*Data interpreta-tion, \*Ecological effects, \*Environmental impact, \*Hazardous wastes, \*Pollutant identification, \*Water pollution effects, Bioassay, Biological studles, Chemical properties, Field tests, In situ tests, Laboratory studies, Model studies, Physical properties, Risk assessment.

Determination of adverse ecological effects at a hazardous waste site (HWS) requires definition of the questions to be assessed plus selection of appro-priate measurement tools. Field observations conpriate measurement tools. Field observations conducted during the initial scoping activities play an important role in defining the ecological concerns to be addressed; the measurement tool box ideally consists of an array of direct field measurements (biological, chemical and physical), in situ bioassays, laboratory bioassays, additional analytical measures of site samples as well as statistical and risk assessment modeling. Each approach (ie., field surveys tracity tests and biomarkers) contains surveys, toxicity tests, and biomarkers) contains numerous methods to acquire data for site assessments. Given the restrictions imposed by time, access, and resources, the selection of methods must be compatible with the specific site data quality objectives (DQOs). (Author's abstract) W91-10258

CHARACTERISTICS OF PILOT- AND FULL-SCALE HAZARDOUS WASTE INCINERATOR

Environmental Protection Agency, Cincinnati,

OH.

G. J. Carroll, and D. A. Oberacker.

Available from the National Technical Information
Service, Springfield, VA. 22161, as PB90-134996.

Price codes: A02 in paper copy, A01 in microfiche.
Report No. EPA/600/D-89/232, 1989. 7p, 6 tab,

12 ref.

Descriptors: \*Ash, \*Hazardous wastes, \*Incineration, \*Pollutant identification, \*Waste treatment, \*Wastewater treatment, Acetone, Arsenic, Chromium, Copper, Heavy metals, Lead, Metals, Naphthalenes, Nickel, Organic compounds, Phenols, Phthalates, Pyrene, Silver, Toluene, Trichloroethane, Trichloroethene, Volatile organic compounds, Xylenes, Zinc.

This review encompasses ash characterization data from 16 different hazardous waste incinerators, both pilot-scale and full-scale, treating a variety of waste streams. Its focus is on 14 volatile organic compounds (VOCs) 18 semivolatile organics, and 13 metals for which analyses were most frequently performed. Included are results of analyses of ash leachate prepared according to EPA's Toxicity Characteristic Leaching Procedure (TCLP). The most frequently detected metals in the ash analyses (as indicated by the fraction of analyses that were above detection limits) were chromium, zinc, copper, nickel, lead, arsenic, and silver. The most frequently detected volatile organic compounds were toluene, xylene, trichloroethene, acetone, methylene chloride, and trichloroethane. Predominant semivolatile organics were bis (2-ethyl hexyl) phthalate and pyrene. Metals were generally detected with greater frequency than organic compounds. Because this review is based on different incinerators treating a variety of wastes under different conditions, it is difficult to isolate the effects of specific variables (ie., incinerator operaning conditions, waste feed characteristics) on ash quality. It is recommended that dedicated parametric testing be conducted to determine such effects. (Author's abstract)

EVALUATION OF TYPE AND CONTENTS OF HUMIC SUBSTANCES IN SLUDGES AND COMPOSTS.

Udine Univ. (Italy). For primary bibliographic entry see Field 5E. W91-10288

CHEMICAL METHODS FOR ASSESSING BIO-AVAILABLE METALS IN SLUDGES AND SOILS.

For primary bibliographic entry see Field 5B. W91-10291

CHEMICAL FORMS AND REACTIVITIES OF METALS IN SEDIMENTS.

Technisch Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik. For primary bibliographic entry see Field 5B. W91-10292

REASONS TO USE NEUTRAL SALT SOLUTIONS TO ASSESS THE METAL IMPACT ON PLANT AND SOILS.

For primary bibliographic entry see Field 5B. W91-10294

WISCONSIN'S GROUNDWATER MONITOR-ING PROGRAM FOR PESTICIDES.

K. Kessler.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 105-113. 2 tab.

Descriptors: \*Groundwater pollution, \*Monitoring, \*Path of pollutants, \*Pesticides, \*Water pollution control, \*Water quality standards, \*Wisconsin, Administrative agencies, Environmental protection, Groundwater monitoring programs, Groundwater quality, Legislation.

The Wisconsin groundwater monitoring program for pesticides was initiated by an interagency committee formed after reports of groundwater contamination by pesticides in the early 1980s. The

committee recommended that the pesticide monitoring program identify susceptible areas in the state, identify crops in those areas and pesticides used in their production, and finally, designate priority pesticides based upon known occurrence in groundwater, leaching potential, and toxicity. Legislation based upon the recommendations (1983 Wisconsin Act 410) was enacted in May 1984. The groundwater standards provision of Wisconsin statutes utilizes an interagency approach to set comprehensive limits. Two standards are generated for each chemical: an enforcement standard, similar to a drinking water standard; and a Preventative Action Limit, which is a fraction of the enforcement standard and is designed to give a higher degree of protection. A main provision of Act 410 is the creation of a statewide groundwater monitoring system with five categories: (1) problem assessment monitoring; (2) at-risk well monitoring; (3) regulatory monitoring; (4) management practice monitoring; and (5) monitoring planning. The pesticide most often detected in Wisconsin's groundwater has been aldicarb. Also frequently present are atrazine, alachlor, and metolachlor. It is recommended that development of a monitoring scheme for pesticides in groundwater involve the U.S. EPA, and state agencies for drinking water, health, agriculture, and geology, as well as the academic community. The importance of data management in a monitoring system for pesticides is underscored. (See also W91-10423) (MacKeen-PTT)

MINNESOTA PESTICIDE MONITORING SUR-VEYS: INTERIM REPORT.

Minnesota Dept. of Health, Minneapolis. T. Klaseus.

In: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 137-146. 5 fig, 9 tab.

Descriptors: \*Agricultural chemicals, \*Groundwater pollution, \*Minnesota, \*Path of pollutants, \*Pesticides, \*Well water, Aquifer characteristics, Baseline studies, Drinking water, Human population, Leaching, Nitrates, Pesticide residues, Population exposure, Water quality monitoring.

The Minnesota Department of Health and the Minnesota Department of Agriculture are currently conducting surveys of water wells for selected pesticides to develop baseline information on the nature and extent of agricultural pesticide contamination in the state's groundwater and drinking water. Thirty pesticides were selected for inclusion in surveys based on use, toxicology, and environmental fate and transport data. Well selection was focused on agricultural areas in which the soil and hydrogeologic conditions result in increased susceptibility to groundwater contamination by pesticides. Karst formations in south-eastern Minnesota and sand and gravel aquifers in central and west-central Minnesota were viewed as particularly sensitive. In total, one or more pesticides were detected in 38% of the 500 wells sampled. Fourteen compounds, including eleven herbicides and three insecticides have been detected and confirmed. Atrazine was by far the most commonly detected pesticide, found in 35% of the wells tested and in over 90% of pesticide-positive wells. Typical pesticide concentrations were below the Minnesota Department of Health recommended drinking water limits. Survey results indicated that, while pesticides and nitrates are not always a reliable indicator of pesticide contamination. The frequency of positive findings and the number of pesticides detected, although typically in low concentrations, suggest cause for concern about Minnesota's groundwater and drinking water. (See also W91-10423) (MacKeen-PTT)

SAMPLING PROBLEMS FOR THE CHEMICAL ANALYSIS OF SLUDGE, SOILS AND PLANTS.

Proceedings of a Round Table Seminar held November 6-7, 1985, in Bordeaux, France. Elsevier Science Publishing Co., New York. 1986, 94p. Edited by A. Gomez, R. Leschber, and P. L'Hermite.

Descriptors: \*Biological samples, \*Chemical analysis, \*Pollutant identification, \*Sampling, \*Sludge, \*Sludge analysis, \*Sludge utilization, \*Trace elements, Analytical methods, Path of pollutants, Plants, Pollutants, Soil analysis, Soil types, Toxic wastes, Variability, Wastes.

Sampling methods for the chemical analysis of sludge, soils, and plants are reviewed. Agricultural use of sludge and increases in sludge quantities generated have prompted the establishment of Concerted Action COST 68 to study the beneficial and harmful effect of the agricultural use of sludge and the levels and environmental effects of harmful substances in sludge. Although improvements in analytical techniques enabled the determination of harmful substances in sludges with great accuracy, unsatisfactory reproducibility was being introduced by improper sampling and sample preparation. Experience in sampling of sludges, soils, and plants has been gained in Ireland, in England and Wales on the agricultural use of sewage sludge, and in the Ruhr River basin for sludge and river sediments. Obtaining representative samples and proper application of statistical analysis are two important sampling problems. Specific sampling precautions are tailored to individual sampling sites. Seven of the papers given at the seminar dealt with sampling of sludge or soil. (See W91-10462 thru W91-10468) (MacKeen-PTT)

SAMPLING OF SOILS, HERBAGE, ANIMAL MANURES AND SEWAGE SLUDGE FOR TRACE ELEMENT AND OTHER ANALYSES: IRISH EXPERIENCES.

Johnstown Castle Research Centre, Johnstown (Ireland).

G. A. Fleming, H. Tunney, and E. G. O'Riordan. IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Publishing Co., New York. 1986. p 6-17. 2 fig, 6 tab, 11 ref.

Descriptors: \*Biological samples, \*Pollutant identification, \*Sampling, \*Siludge analysis, \*Siludge disposal, \*Soil analysis, \*Trace elements, Analytical methods, Manure, Plants, Sludge, Soil types.

Sampling factors affecting trace element levels in soils, plants, manures and sewage sludges were studied. Compositional differences in the parent rocks are reflected in trace metals levels in soils. The availability of most nutritionally important trace elements decreases with increasing pH. Availability of molybdenum, manganese, and cobalt increases with increasing soil moisture. The availability of trace elements is also conditioned by interactions with other elements. Sampling plants for trace element analysis requires consideration of a number of factors: type of sampling tool; soil contamination; plant species; stage of growth; season; and plant part. Special considerations in sampling of animal manures include mixing to obtain a representative sample, accounting for differences in water content, and settling of solids. Sampling sewage sludge for trace element analysis also requires special consideration to obtain representative samples. A wide day-to-day variation in the waste entering a sewage treatment plant necesitates frequent sampling of sludge to obtain an estimate in the variation of sludge trace element contents. It is concluded that sampling of biological materials for trace elements requires special precautions which vary depending on the nature of the material being sampled. (See also W91-10461) (MacKeen-PTT) W91-10462

SAMPLING AND ANALYSIS OF SLUDGES AND SOILS IN ENGLAND AND WALES FOR THE MANAGEMENT OF AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE.

Severn-Trent Water Authority, Birmingham (Eng-

# **Group 5A—Identification Of Pollutants**

For primary bibliographic entry see Field 5E. W91-10463

EXPERIENCES WITH SLUDGE SAMPLING IN THE RUHR RIVER BASIN.

H. Herkelmann, and P. Koppe.

IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Publishing Co., New York. 1986. p 27-37, 8 fig, 6 ref.

Descriptors: \*Pollutant identification, \*Sampling, \*Sediment analysis, \*Sludge, \*Sludge analysis, \*Sludge disposal, Germany, Heavy metals, Quality control, Ruhr River, Wastewater treatment.

Methods of sludge sampling are illustrated using case studies performed by the Ruhr River Association. Wastewater treatment by 118 plants in the Ruhr River basin produces 1.9 million cu m of sewage sludge annually. Analysis of digested sludge from 100 treatment plants during 1984 indicated variation of several orders of magnitude in concentrations. cated variation of several orders of magnitude in chromium, copper, nickel, and zinc concentrations. German legislative standards for agricultural application of sludges were exceeded in 25.4%, 19.1%, 13.6%, and 31.8% of cases for zinc, copper, chromium, and nickel, respectively. Sampling sediments of river impoundments is performed by sludge grabs for deep impoundments, and by sludge lifter, which preserves the stratification of the samples, for shallow impoundments. Sludge sampling of dredged sludge in impassible deposit ponds requires the use of a mobile derrick-type crane with suspension basket. Gas sampling of ponds requires the use of a mobile derrick-type crane with suspension basket. Gas sampling of sludge digestors is performed by a floating gas collector. The separation of gas bubbles from activated sludge flocks is achieved by intermittent revolving of a one-liter sample of sludge and wastewater. It is concluded that appropriate sam-pling of ludges and estimants requires advantagion pling of sludges and sediments requires adaptation to local circumstances. (See also W91-10461) (MacKeen-PTT) W91-10464

SOIL SAMPLING FOR TRACE ELEMENT ANALYSIS AND ITS STATISTICAL EVALUA-

Landwirtschaftlich-chemische Bundesanstalt, 4025

Linz, Austria. K. Aichberger, A. Eibelhuber, and G. Hofer. IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Pub-lishing Co., New York. 1986. p 38-44. 2 fig, 4 tab, 5

Descriptors: \*Heavy metals, \*Pollutant identifica-tion, \*Sampling, \*Sludge, \*Sludge disposal, \*Soil analysis, \*Statistical analysis, \*Trace metals, Error analysis, Field tests, Sludge utilization, Soil con-tamination, Statistical methods.

The variability of the concentrations of acid-soluble heavy metals in a field fertilized with sewage sludge was studied. Samples (sub-samples numbering 100, 50, 25, 16, and 9) were taken from test areas of 1, 100, and 10,000 sq m. Individual samples areas of 1, 100, and 10,000 sq m. Individual samples were analyzed for copper, zinc, nickel, chromium, lead, and cadmium and statistical parameters were calculated for groups of samples. Taking the average heavy metal concentrations as a reference point (100%), the sub-samples varied between 35 and 200%. The variability for the 1 and 100 sq m test areas was much lower than that for the 10,000 sq m area. The sampling arror was 20% are samples. sg m area. The sampling error was 20% per sample on average. Due to the fact that the variation reflecting field heterogeneity of metal concentrations was 2-6 times greater than the variation of analysis, it was calculated that 20 sub-samples per 10,000 sq m area would be required for reliable trace metal determinations. To check whether a defined tolerance limit has been exceeded, the use of the one-sided statistical t-test is proposed. (See also W91-10461) (Author's abstract) W91-10465

PROBLEMS OF SAMPLING SOIL FAUNA FOR TERRESTRIAL ECOLOGICAL STUDIES, Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands).

A. Minderhoud. IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Pub-lishing Co., New York. 1986. p 52-54. 8 refs.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Land disposal, \*Pollutant identification, \*Sludge disposal, \*Soil contamination, Fauna, Halogenated organic compounds, Heavy metals, Nematodes, Oligochaetes, Sampling, Sludge, Sludge utilization, Soil analysis.

The sampling of fauna grown on sludge-amended soils for analysis of availability and accumulation of pollutants is discussed. Earthworms are suitable organisms to indicate contamination of a terrestrial ecosystem because they form 90% of the inverte ecosystem occause they form 90% of the inverte-brate biomass in the soil, and because they ingest enormous quantities of earth. Sampling of earth-worms is normally performed by hand-sorting from a representative quantity of soil. Since up to 30% of the fresh body weight of earthworms is earth in the gut, a method for cleaning the gut must be used to determine pollutant concentrations in worm tissue. Studies have shown selective accuin worm tissue. Studies have shown selective accu-mulation of cadmium and zinc in earthworms grown on sludge-conditioned soil. Total popula-tions of earthworms were reduced by a factor of tions of earthworms were reduced by a factor of polychlorinated biphenyls, DDT, and DDE was also found. It is concluded that soil fauna such as earthworms and nematodes can serve as bioindicators of soil contamination. (See also W91-10461) (MacKeen-PTT) W91-10466

SAMPLING TECHNIQUES FOR SLUDGE, SOIL AND PLANTS.

SOIL AND PLANTS.
I.N.R.A., Station d'Agronomie, Centre de Reserches de Bordeaux, Port de la Maye, France.
A. Gomez, R. Leschber, and F. Colin.
IN: Sampling Problems for the Chemical Analysis
of Sludge, Soils and Plants. Elsevier Science Publishing Co., New York. 1986. p 80-90. 17 ref, 4

Descriptors: \*Biological samples, \*Pollutant identification, \*Sampling, \*Sludge analysis, \*Soil analysis, \*Trace elements, Analytical methods, Land disposal, Path of pollutants, Plants, Sludge, Sludge disposal, Soil types, Variability.

Sampling techniques for sludge, soil, and plants are reviewed. In sampling of sludges, particular attention is required to obtain a representative sample. Sampling during sludge flow or handling is preferred to sampling from a deposit or storage area. Due to accessibility problems, special systems are necessary for sampling in lagoons. Homogenization of samples is required prior to subdivision and analysis. Use of dried sludge samples for analysis leads to responsals accuracy and reproducibility. leads to reasonable accuracy and reproducibility. Possible heterogeneity of the material requires that rossion heterogeneity of the material requires that an adequate number of single samples be taken from different sites and pooled to form a represen-ative sample. The use of variographic analysis and multifactorial statistical analysis have been useful mutitactorial statistical analysis have oeen useful in determining the structure of sludge deposits. Several steps are used in soil sampling: collection of elementary field samples; sample pretreatment and possible preparation of a composite sample; and laboratory treatment. Multiple samples are required to determine the distribution of constituents within a plot. Special considerations in plant sampling include definition of plant number and part to ping include definition of plant number and part to be sampled, reducing sample contamination during the sampling procedure, and sample preservation by refrigeration, freezing, or desiccation. It is con-cluded that sampling is a decisive step in the study of pollutant transfers from sludge to soil and plants. (See also W91-10461) (MacKeen-PTT) W91-10468

# 5B. Sources Of Pollution

RANGELAND AND TERRACED WHEATLAND ABOVE SALINE SEEPS.
Southern Plaine P.

Southern Plains Range Research Station, Woodward, OK.

For primary bibliographic entry see Field 4C. W91-09328

GROUNDWATER QUALITY.

Nebraska Univ., Lincoln. Dept. of Agronomy For primary bibliographic entry see Field 4C.

WATER-SOLUBLE FRACTIONS OF HEAVY METALS DURING COMPOSTING OF MUNICIPAL SOLID WASTE.

Udine Univ. (Italy). L. Leita, and M. De Nobili. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 73-78, January/March 1991. 9 fig, 23

Descriptors: \*Composting, \*Heavy metals, \*Land disposal, \*Municipal wastes, \*Path of pollutants, Cadmium, Copper, Hydrogen ion concentration, Lead, Organic carbon, Soil chemistry, Waste dis-

The need to assess the limitations of compost on agricultural soils has created a demand for information on the availability of metals in municipal soild waste compost. This study was done to determine the water-extractable fractions of Cd, Zn, Cu, and Pb and investigate changes in water-Zn, Cu, and Pb and investigate changes in water-soluble organic C during the complete composting of a pile of ground municipal solid waste. Samples were collected every 3-5 d for 60 days. The pro-gressive increase in total heavy metals concentra-tions during the composting period was not ac-companied by a corresponding increase in the water extractable amounts of metals. Water ex-tractable fractions of Pb and Zn decreased rapidly with correcting time and a more complex backy with composting time, and a more complex behavior was observed for Cu and Cd. No relationship was found between pH and extractable fractions of all metals higher amounts of Pb and Zn were extracted when the pH of the composting material was below neutrality. The total soluble C concentration of extracts rapidly decreased during the tration of extracts rapidly decreased during the first days of composting. There was a significant correlation between water extractable Pb (r = correlation between water extractable Po (r = 0.98) and  $\Sigma_1$  (r = 0.98), and water extractable C of nonhumic decomposition products. The water extractable fraction of Cu was significantly correlated only with water soluble humic C (r = 0.94). No correlation was found for the water extractable fraction of Cd. The degree of stabilization reached by organic matter appears to be important in deter-mining potential mobility of heavy metals. (Author's abstract) W91-09335

MODELING SELENIUM TRANSPORT IN STEADY-STATE, UNSATURATED SOIL COL-

California Univ., Davis. Dept. of Land, Air and Water Resources.

M. H. Alemi, D. A. Goldhamer, and D. R.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 89-95, January/March 1991. 9 fig, 2 tab, 20 ref.

Descriptors: \*Model studies, \*Path of pollutants, Selenium, Soil columns, Adsorption, Biotrans-formation, Chemical analysis, Loam, Selenium compounds, Simulation analysis, Soil chemistry, formation,

This study was conducted to characterize batch adsorptions of selenate, selenite, and selenometh-ionine (Se-CH2CH2CHNH2COOH)2 and transformations of Se in the presence of microbial activity in Panoche loam (fine loamy, mixed, calcareous, thermic Typic Torriorthents). The effects of sterilization, enhanced microbial activity, and anaerobic vs aerobic conditions on the transport of pulse-fed Se in soil columns were also investigated. Selenate was rapidly leached in the soil columns compared with selenomethionine and selenite both of which invaded the columns to only a limited extent. Adsorption was highest for selenite and least for selenate. Selenate was transformed to reduced and less

### Sources Of Pollution-Group 5B

mobile forms when soil was C-enriched, particularly with smaller water fluxes and under anaerobic conditions. Systems of partial differential equations involving equilibrium adsorption of Se were set to simulate the transport of selenate, selenite, at selenomethionine under sterilized conditions. The transport model was solved by an iterative procedure using a finite difference scheme. Experimentally determined adsorption parameters of selenite and selenomethionine did not produce a satisfac-tory fit when used in simulation of these Se species in column studies. However, Se transport model dequately simulated Se concentrations lution under sterilized conditions when the adsorption coefficients derived from batch experiments were adjusted. No transport modeling was considered for nonsterilized conditions. (Author's abstract) W91-09337

HYDRIDE GENERATION ATOMIC ABSORPTION TECHNIQUE FOR ARSENIC SPECIATION.

Louisiana State Univ., Baton Rouge, Lab. for Wetland Soils and Sediments.

P. H. Masscheleyn, R. D. Delaune, and W. H.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 96-100, January/March 1991. 5 fig, 1 tab, 16 ref.

Descriptors: \*Analytical methods, \*Arsenic, \*Chemical analysis, \*Laboratory methods, \*Path of pollutants, \*Pollutant identification, \*Speciation, Atomic absorption spectrophotometry, Gas chromatography, Heavy metals, Separation techniques, Trace elements. Trace elements

Speciation is important when studying environmental behavior of arsenic (As), since major fea-tures affecting the movement and toxicity of As are associated with changes in the oxidation states and the resulting differences in the chemical properties of these various forms. Based on an investigation of hydride generation responses in solutions of various acidities containing nanogram quantities of arsenite (As III), arsenate (As V), monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA), a sensitive analytical method for the (DMAA), a sensitive analytical method for the accurate determination of organic and inorganic As species in aqueous solutions was developed. After a pH-selective reduction, the arsenic species were condensed in a U-tube filled with a gas chromatographic packing immersed in liquid N2. The species were then separated by slow warming of the trap, and measured with an atomic adsorption spectrophotometer. The arsines from inorgan-ic As(III) were selectively generated from a solu-tion buffered at a pH of 6.0. The solution was then further acidified to a pH corresponding to a 2 M HC and analyzed for As(V). A second sample aliquot, buffered at pH 1.5 with oxalic acid, was used for the quantitative determination of As(III)+AS(V), MMAA and DMAA. (Doyle-PTT) W91-09338

FOUR-YEAR MOBILITY STUDY OF SELECTED TRACE ELEMENTS AND HEAVY METALS.

Atomic Energy of Canada Ltd., Pinawa (Manitoba), Whiteshell Div.
M. I. Sheppard, and D. H. Thibault.
Journal of Environmental Quality JEVQAA, Vol.
20, No. 1, p 101-114, January/March 1991. 8 fig, 5 tab, 37 ref.

Descriptors: \*Heavy metals, \*Path of pollutants, \*Trace elements, Adsorption kinetics, Cesium, Chromium, Cores, Groundwater pollution, Indus-trial wastes, Iodine, Leaching, Lysimeters, Molybdenum, Soil chemistry, Soil contamination, Technetium, Thorium, Uranium.

The environmental impact of accidental or chronic releases of contaminants to the unsaturated soil zone, either through surface spills or contaminated groundwater, has become a major concern. This study was designed to provide data after 1 and 4 yr to compare the leaching and upward transport of Tc, I, Np, Cs, U, Th, Cr, and Mo in cores of the same soil in outdoor lysimeters. Over the 4 yr study a broad range of climatic, soil moisture, and temperature conditions existed which were representative of long-term means as well as some ex-tremes. The amount of rainfall which leached through the cores decreased with time. The leaching resulted in a downward movement of fine soil ing resulted in a downward movement of fine soil particles, especially in the lower horizons. Element mobility in the leaching cores for the 4 yr decreased in the order 1 > Tc >> Cr > Np > Mo > Cs > U > Th. This differs slightly from the ranking predicted after 1 yr. After 1 yr, Mo appeared to be more mobile than Cr or Np. After 4 yr, I, Tc, Np, and Cs migrated to the soil surface from depth. Analysis of the soil solid/liquid partition coefficient values indicates that the retention of these elements is primarily related to soil organ. tion coefficient values indicates that the retention of these elements is primarily related to soil organic matter content and dependent on soil pore water concentration. The soil solid/liquid partition coefficient model is appropriate for I in all soil horizons and for Tc, Np, and Cs in the Ae horizon of the groundwater cores. The Freundlich isotherm or a kinetic expression best describes the sorption for all other elements and horizons. (Author's abstract) W91-09339

TRACE METAL MOVEMENT IN AN AERIC OCHRAQUALF FOLLOWING 14 YEARS OF ANNUAL SLUDGE APPLICATIONS.

DEPUT AND A STREET OF THE STREET OF T

Descriptors: \*Heavy metals, \*Land disposal, \*Path of pollutants, \*Sludge, \*Sludge disposal, \*Trace metals, Cadmium, Copper, Municipal wastes, Soil contamination, Waste disposal, Zinc.

The potential for movement of sludge-borne trace elements beyond the plant root zone is addressed by sampling an Aeric Ochraqualf (Blount Series) after 14 yr of massive, sludge additions (765 Mg/ha cumulative sludge applications, dry wt. basis). Cadmium, Zn, and Cu concentrations in each genetic horizon to a depth of 1.0 m were determined by atomic absorption spectrophotometric analyses of 4.0 M HNO3 extracts. In addition, ped surfaces (cutans) and intra-ped material (s-matrix) from pris-matic structural units of the lower B and upper C horizons were analyzed to determine the partition-ing of trace metals in this highly structured profile. ing of trace metals in this highly structured profile.

Cadmium concentrations in the subsoil of sludgetreated areas were consistently and significantly
higher (about 0.4 mg/kg) than levels present in the
control areas. Similarly, Zn concentrations in the
0.32 to 0.51 m region (Bt1) were increased (approximately 12 mg/kg) with sludge applications,
no increases in Cu levels were observed. Significantly more Cd (0.08 mg/kg) was present in cutans removed from ped surfaces in the upper B horizon than was observed in the s-matrix for sludge-treated areas. Cutans also contained more sludge-borne Zn than the associated s-matrix. This evidence suggests that small amounts of sludge-borne Cd suggests that small amounts of sludge-borne Cu and Zn moved out of the tillage zone into the subsoil of this highly structured agricultural soil over a 14 yr period of massive sludge additions. (Author's abstract) W91-09341

INFLUENCE OF FERTILIZER, IRRIGATION, AND NON-GROWING SEASON PRECIPITATION ON SOIL NITRATE-NITROGEN UNDER CORN.

Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources. For primary bibliographic entry see Field 3F. W91-09342

ACCUMULATION AND INTERACTIONS OF ARSENIC, SELENIUM, MOLYBDENUM AND PHOSPHORUS IN ALFALFA.

California Univ., Riverside. Dept. of Soil and Environmental Science A. Khattak, A. L. Page, D. R. Parker, and D.

Journal of Environmental Quality JEVQAA, Vol.

20, No. 1, p 165-168, January/March 1991. 2 fig, 3 tab, 23 ref.

Descriptors: \*Alfalfa, \*Arsenic, \*Bioaccumulation, \*Molybdenum, \*Path of pollutants, \*Phosphorus, \*Selenium, Adsorption, Agricultural runoff, Chemical interactions, Competition, Heavy metals,

Arsenic (As), selenium (Se), and molybdenum (Mo) have become increasingly important in the terrestrial and agrobiological environment in some parts of the western United States. A four factorial (3 As x 3 Se x 2 Mo x 2 P concentrations) com-(1) As x 3 Se x 2 Mo x 2 P concentrations) completely randomized glasshouse study was conducted to evaluate the competitive interactions between As (V), Se (VI), Mo (VI) and P using nutrient solution concentrations representative of soil solutions and agricultural drainage waters. Alfalfa (Medicago sativa) was grown in sand culture and irrigated five times per day with half strength Meadewick solutions activities of Meadewayth and irrigated five times per day with half strength Hoagland's solution containing 0 (background), 0.05 and 0.10 mg/L As as Na2HAsO4; 0, 0.05, and 0.10 mg/L Se as Na2SeO4; and 0.01 (background) and 1.0 mg/L Mo as Na2MoO4. Instead of 16 mg/L P and 16 mg/L S commonly used in half strength Hoagland solution, 1.0 or 4.0 mg/L P added as K2PO4 and one somewhat lower level (8.0 mg/L) S added as MgSO4 were used. The results indicated no adverse effect of As and Se on short visid Selenium and P strongly depressed shoot yield. Selenium and P strongly depressed shoot As concentrations, and their combined effects were multiplicative rather than additive (significant Se x P interaction). Uptake of Se decreased by increasing P, but was stimulated by increasing As, and the combined affects of P and As were approximately additive (non-significant As x P interaction). Tissue concentrations of Mo and P were less dramatically influenced by solution concentrations of the other elements. (Author's abstract) W91-09344

MICROLYSIMETER SOIL COLUMNS FOR EVALUATING PESTICIDE THROUGH THE ROOT ZONE.

Wisconsin Univ.-Madison. Dept. of Soil Science. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 189-195, January/March 1991. 6 fig, 2 tab, 23 ref.

Descriptors: \*Experimental design, \*Laboratory methods, \*Lysimeters, \*Path of pollutants, \*Pesticides, \*Soil columns, Bromides, Carbofuran, Chemical tracers, Chlorpyrofos, Corn, Drainage water, Evapotranspiration, Leaching, Root zone,

Field approaches to studying pesticide movement are subject to numerous variables of the environ-ment, many of which are difficult and expensive to monitor. A microlysimeter consisting of a 1 m length of 0.2 m aluminum irrigation pipe was connected to a vacuum system to simulate field drainage conditions. The 9 kPa suction at the bottom of the soil column approximated soil moisture tension the soil column approximated soil moisture tension at field moisture capacity of intact soil (Plainfield loamy sand, mixed, mesic, Typic Udipsamment) columns used to examine the mobility of two insecticides (carbofuran and chlorpyrifos) through soil from two tillage plots (conventional-moldboard plow and no-till tillage). Field leaching conditions were approximated by simulating a moisture and temperature regime characteristic of a natural soil profile. Measured daily and seasonal temperatures fluctuated according to a pattern characteristic of a field soil. Evapotranspiration (ET) from the soil columns was 61% of the total water applied and was nearly equal to the ET measured (63%) from field lysimeters of this soil planted to corn (Zea mays). Variation in cumulative drainage was small; mays). Variation in cumulative drainage was small; total drainage from all columns was within a range of 3.9 cm. There was no significant difference in the transport of bromide (conservative tracer) through the columns to the two tillage plots. Bromide leachate loss was 62 and 63% of the amount applied for conventional moldboard plow and notill columns, respectively. Intact soil columns established in a microlysimeter fashion provided a means to compare the movement of agricultural

# Group 5B-Sources Of Pollution

chemicals under controlled conditions in the greenhouse that approximate conditions/processes in the field. (See also W91-09346) (Author's abstract) W91-09345

PESTICIDE MOBILITY AND PERSISTENCE IN MICROLYSIMETER SOIL COLUMNS FROM A TILLED AND NO-TILLED PLOT. Wisconsin Univ.-Madison. Dept. of Soil Science. K. J. Fermanich, and T. C. Daniel. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 195-202, January/March 1991. 7 fig, 2 tab, 42 ref.

Descriptors: \*Carbofuran, \*Chlorpyrofos, \*Path of pollutants, \*Pesticides, \*Tillage, Agricultural practices, Bromine, Carbon radioisotopes, Corn, Leaching, Lysimeters.

Pesticide leaching losses under varying tillage systems, especially in sandy soils, is not clearly understood. This study compared the leaching and dissipation of two corn (Zea mays), 14-C labeled, insecticides (carbofuran, (2,3-dihydro-2,2-dimethyl-7-benzo-furanyl-methylcarbamate) and chlorpyrifos O,O-diethyl O-trichloro-2-pyridyl) phosphorothotoate), in sandy soil columns from conventional moldboard plow (CN) and no-till (NT) tillage notes, Microlysimeters, utilizing intact soil columns plots, Microlysimeters, utilizing intact soil columns plots. Microlysimeters, utilizing intact soil columns from established tillage plots, were used to investi-gate pesticide mobility and dissipation under simu-lated field precipitation, drainage, and temperature patterns. Leachate from CN tillage columns repatieris. Learnate from CT image columns re-ceiving 14-C carbofuran contained over two times more of the applied 14-C (17.9%) compared to NT columns (7.9%). The major portion (63%) of 14-C carbofuran residues leached from CN columns was associated with a metabolite (unknown I) compared to 40% for NT columns. Slightly more (4.9 compared to 4.6%) 14-C as parent carbofuran leached from CN columns relative to NT. After 106 d of simulated field conditions, 4.0 and 7.8% of the applied parent 14-C carbofuran was recovered from the soil of CN and NT columns. Average time to peak 14-C carbofuran residue concentra-tions were retarded by 12 and 39 day for CN and NT columns, compared with time to peak concentrations of bromide. Less than 0.2% of the applied 14-C chlorpyrifos leached from the soil columns. Differences in the physical, chemical, and/or biological characteristics between CN and NT tillage columns influenced the dissipation and mobility of carbofuran. (See also W91-09345) (Author's abstract) W91-09346

SULFOMETURON PERSISTENCE AND MOVEMENT IN SOIL AND WATER IN NORTH DAKOTA. North Dakota State Univ., Fargo. Dept. of Crop

and Weed Sciences

R. G. Lym, and O. R. Swenson. Journal of Environmental Qual Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 209-215, January/March 1991. 2 fig, 6 tab, 13 ref.

Descriptors: \*Fate of pollutants, \*Herbicides, \*North Dakota, \*Path of pollutants, \*Soil types, \*Sulfometuron, Biodegradation, Clays, Hydrogen ion concentration, Hydrolysis, Leaching, Loam, Photolysis, Sand, Soil water, Temperature.

The lateral movement, soil persistence and aqueous The atteral movement, soin persistence and aqueous hydrolysis of sulfometuron 2-(4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino) sulfonyl)-benzoic acid, was evaluated. Sulfometuron applied at 140 g ai./ha from slopes to nontarget areas was minimal and was not detected in the 0-30 cm soil depth, when sampled up to 120 cm downslope from the treated area on 2, 8, or 16% slopes 1 yr after treatment. The highest sulfometuron concenafter treatment. The highest sulfometuron concentration found downslope from the treated area was less than 1 microg/kg regardless of the slope. Sulfometuron moved beyond the soil column (70 cm deep) in Fairdale loam (fine-loamy, mixed (calcareous), frigid, Mollic Udifluvents), Felor sitty clay loam (fine loamy, mixed, Typic Agriboroils), and Barnes stony loam (fine loamy, mixed, Udie Haploborolls) soils when leached with 45.7 cm of water for 48 hr, compared to only 35 to 50 cm

deep when leached with the same amount of water over 9 wk. Sulfometuron degradation increased as soil temperature and moisture increased. Sulfometuron was detected for an average of 429 d in Felor silty clay loam at pH 6.1 8 C, and 45% field capacity but only 218 d in the same soil at 90% field capacity and 16 C. Degradation was slower in Renshaw and Sioux sandy loam (undifferentiated soil mixture) fine loamy over sandy of sandy skelesoil mixture) fine loamy over sandy of sandy skele-tal, mixed Udic Haploborolls and sandy skeletal, mixed Udortheutic Haploborolls ) with a pH of 7.4 and averaged greater than 700 d, regardless of environmental conditions. Sulfometuron hydrolysis was similar regardless of solution pH with an average of 63% 14-C sulfometuron remaining after average of 0.5% of 4-C sulformeturon remaining after 28 d in water at pH 5, 7, and 9. The average half-life of 14-C sulfometuron was 31 and 65 d in ultraviolet irradiated and dark control samples. (Author's abstract) W91-09347

SORPTIVE REVERSIBILITY OF ATRAZINE AND METOLACHLOR RESIDUES IN FIELD SOIL SAMPLES.

Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water. J. J. Pignatello, and L. Q. Huang. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 222-228, January/March 1991. 3 fig, 5 tab, 27 ref.

Descriptors: \*Atrazine, \*Herbicides, \*Metolachlor, \*Path of pollutants, \*Sorption, Adsorption kinetics, Adsorption-desorption, Model studies, Soil

Slowly reversible, or nonequilibrium, sorption occurs as a result of diffusion-limited transport of sorbate molecules through soil structures. This may contribute to persistence of contaminants in soil by hindering transport and reducing availabil-ity to degrader microorganisms. Predictions of the fate and transport of organic compounds in soils depends on sound sorption models; the impacts of acpenas on sound sorption models; the impacts of monequilibrium sorption on compound fate are not well quantified. Soil samples containing residues of the herbicides atrazine (2-chloro-4-ethylamino-6-isopropyl-1,3,5-triazine) and metolachlor (2-chloro-N-(2-ethyl-3-methylphenyl)-N-(2-methoxy-1-methylethyl)-aceamide) were collected from fields 2 to 15 mo after their last application to assess the sorptive reversibility of these residues. The apparent sorption constant of the native herbicide, was determined from the school and solution compared to the state of the state of

determined from the sorbed and solution concentrations after suspension of the sample in water for 24 h. The 'equilibrium' sorption constant was determined in the same samples from 24 h sorption sotherms of freshly added herbicide, taking into account the fraction of labile native herbicide. The ratio of the apparent sorption constant to the 'equilibrium constant varied from 2.3 to 42 and was directly related to the age of the residue. The results indicate that contaminated samples collected from the field can contain a large fraction of contaminant in a slowly reversible sorbed state, and that this fraction increases with time. (Author's abstract) W91-09348

RAILWAY RIGHT-OF-WAY CONTAMINANTS IN THE LOWER MAINLAND OF BRITISH CO-LUMBIA: POLYCYCLIC AROMATIC HYDRO-CARBONS.

Environmental Protection Service, West Vancouver (British Columbia). Pacific and Yukon Region.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 228-234, January/March 1991. 2 fig, 5 tab, 14 ref.

Descriptors: \*British Columbia, \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Railroads, \*Water pollution sources, Burrard Inlet Creosote, Organic compounds, Salmon, Sediment contamination, Sediments, Stream fisheries, Water pollution effects.

In order to assess the occurrence and levels of polycyclic aromatic hydrocarbon (PAH) contami-nation, resulting from such railroad sources as locomotive exhaust, use of wood preservatives like

creosote, and herbicides, the ballast from five rail-road rights-of-way and ditches flowing adjacent to salmon streams were sampled in 1989 on the Lower Mainland of British Columbia, Canada. The levels of 16 selected PAH were referenced against background samples taken from ditches leading to fish streams in pristine parklands and agricultural lands, in addition, PAH levels reported in sedi-ments from Burrard Inlet (Inner Harbour), the ments from Burrard Inlet (Inner Harbour), the commercial harbour of Vancouver, British Columbia, were also used for comparison. All 16 PAHs were found in the ballast and ditch sediments/water of the five railway rights-of-way. In the ballasts, total levels of the 16 PAH varied from 1.562-58.773 g/sq m, averaging 18.069 g/sq m. The mean concentration of the total 16 PAH in ditch mean concentration of the total 10 PAI in ditch sediments was 213.47 micrograms/g (range 1.89-1168.71 micrograms/g). PAH were not consistent-ly found in ditch water at all study sites. But at sites where they occurred, the selected 16 compounds had an average total concentration of 606.9 micrograms/L (range, 1-3515.9 micrograms/L). PAH were not detected in the ditches of pristine parklands but low concentrations were detected in parkiands but low concentrations were detected in some of the agricultural samples. The total level of PAH in sediments from railway ditches were re-spectively 205 and 40 times higher than levels found in the sediments of farmland ditches and Burrard Inlet. The biological implications of these PAH contaminated sediments is still poorly understood. However, recent studies suggest the possi-bility that chronic exposure to low levels may negatively affect the hatching process and swimming behavior of certain species of juvenile salmon. Replacement of wooden ties with concrete samon. Replacement of wooden ties with concrete ones, and the use of pressurized steam for weed control would greatly reduce two of the major sources of PAH along railroad rights-of-way. (Doyle-PTT)

MEASUREMENT OF BIOAVAILABLE PHOS-PHORUS IN AGRICULTURAL RUNOFF. Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. For primary W91-09350 bibliographic entry see Field 5A

WATER QUALITY IMPACTS ASSOCIATED WITH SORGHUM CULTURE IN THE SOUTH-

RYPERN PLAINS.
Agricultural Research Service, Durant, OK.
Water Quality and Watershed Property of the Control o Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 4C. W91-09351

LONG-TERM IONIC INCREASES FROM A CENTRAL APPALACHIAN FORESTED WATERSHED.

Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab. P. J. Edwards, and J. D. Helvey. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 250-255, January/March 1991. 5 fig, 5 tab, 21 ref.

Descriptors: \*Acid rain effects, \*Conductance, \*Environmental chemistry, \*Environmental effects, \*Forest management, \*Forest watersheds, \*Ion transport, \*Stream pollution, Calcium, Dissolved solids, Leaching, Nitrates, Nitrification, Nonpoint pollution sources, Soil chemistry, Sulface.

The electrical conductivity of stream water drain-The electrical conductivity of stream water draining from an unmanaged and undisturbed control watershed has been increasing rather steadily, about 0.03 mS/m/yr, since 1971. During this period, NO3(-) and Ca(2+) concentrations increased and were shown to mathematically account for the ionic contribution to conductivity; therefore, they are believed to be primarily responsible for the increase. However, the percentage of conductivity explained by the two ions was different over time. The percentage of conductivity ent over time. The percentage of conductivity attributable to NO3(-) increased in a pattern very similar to concentration. In contrast, the percentage of conductivity attributable to Ca(2+) decreased slightly over time. The Ca(2+) is believed

### Sources Of Pollution—Group 5B

to be pairing with the NO3(-) as the NO3(-) ions leach through the soil. While nitrification in mature stands can be strongly inhibited, limited nitrification, especially in forest gaps, and high anthropogenic inputs of NO3(-) probably were the primary sources of the leached NO3(-). Preferential adsorption of SO4(2-), rather than NO3(-), on soil colloids is given as an explanation for the lack of retention of NO3(-) in the soil system and subsequent leaching to the stream. If this is indeed the situation, then special timber management practices may have to be considered in mature or overmature stands growing in areas of high overmature stands growing in areas of high SO4(2+) deposition so that NO3(-) displacement losses do not become excessive and negatively effect soil nutrient status or stream productivity. (Author's abstract) 791-09353

PESTICIDE AND NUTRIENT MOVEMENT INTO SUBSURFACE TILE DRAINS ON A SILT LOAM SOIL IN INDIANA.

Purdue Univ., Lafayette, IN. Dept. of Agronomy.

E. J. Kladivko, G. E. Van Scoyoc, E. J. Monke,

K. M. Oates, and W. Pask.

Journal of Environmental Quality JEVQAA, Vol.

20, No. 1, p 264-270, January/March 1991. 2 fig, 7 tab, 26 ref.

Descriptors: \*Drainage systems, \*Nonpoint pollution sources, \*Nutrient transport, \*Path of pollutants, \*Pesticides, \*Soil water, \*Water pollution sources, Adsorption, Agricultural water, Alachlor, Atrazine, Carbofuran, Cyanazine, Indiana, Loam, Nitrogen, Phosphorus, Soil types, Tile drainage, Tile drainage,

Field scale pesticide and nutrient losses to subsurface tile drains were determined over a 3 yr period on a low organic matter and poorly structured silt loam soil under typical agricultural management practices. A subsurface drain spacing study was instrumented to measure drain discharge rates and instrumented to measure drain discharge rates and to collect drainflow samples continuously on a flow-proportional basis. Two replicates of three drain spacings (5, 10, and 20 m) were included in the study. Water samples were analyzed for all applied pesticides (atrazine, cyanazine, alachlor, carbofuran terbufos, and chlornyrifos) as well as applied pesticides (atrazine, cyanazine, alachlor, carbofuran, terbufos, and chlorpyrifos) as well as major nutrients (N, P, K) and sediment. Small amounts of carbofuran, atrazine, cyanazine, and alachlor were detected in subsurface drainflow within 3 wk of pesticide application and after less than two com net subsurface drainflow from the soil. This early arrival of pesticides at the drain is consistent with preferential flow concepts. Annual carbofuran losses in subsurface downflow ranged from 0.8 to 14.1 c/hs or 0.05 to 0.04% of the from 0.8 to 14.1 g/ha, or 0.05 to 0.94% of the amount applied. The rank-order of pesticide mass losses corresponded with the rank-order of sorp-tion coefficients of the pesticides. Total mass of non coefficients of the pesticides. Total mass of pesticides, nutrients, sediment and water removed by subsurface drains on a per-area basis was greatest for the 5 m spacing and least for the 20 m spacing. Annual nitrate-N losses to subsurface drainflow ranged from 18 to 70 kg/ha and averaged 41.7 kg/ha. Annual average ammonium-N, soluble P, and K losses were 0.5, 0.04, and 2.6 kg/ha. (Author's abstract)

RELATIONS AMONG NAOH-EXTRACTABLE PHOSPHORUS, SUSPENDED SOLIDS, AND ORTHO-PHOSPHORUS IN STREAMS OF WY-

OMING.
Wyoming Univ., Laramie. Dept. of Zoology and Physiology.
M. Parker.

Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 271-278, January/March 1991. 5 fig, 2 tab, 30 ref.

Descriptors: \*Analytical methods, \*Data interpre-tation, \*Eutrophication, \*Nutrients, \*Path of pol-lutants, \*Phosphorus, \*Regression analysis, \*Statistical analysis, Analysis of variance, Beaver ponds, Cluster analysis, Nutrient transport, Prediction, Statistical methods, Suspended solids, Wastewater facilities, Wyoming.

During 1984-1986, 369 water samples from seven streams and a sewage treatment plant in Wyoming

were analyzed for NaOH-P, ortho-P (OP), and suspended solids (SS). Regressions predicting NaOH-P were developed from data on SS and OP, plus information on variability in time (year of sampling), meteorology, (volume discharge), and presence or absence of beaver (Castor sp.) dams. Scatter plots, ANOVA, and cluster analyses indi-Scatter plots, ANOVA, and cluster analyses indi-cated data could be aggregated into four groups reflecting processes that differ among the eight stations, and index a component of spatial variabili-ty. Adjusted R-squared and precision (95% confi-dence limits for the mean) always tended to be poor when OP was more influential in affecting MOUL Haten was S. (Recovered 21, 1989). poor when OP was more influential in affecting NaOH-P than were SS (R-squared = 21-88%); only in some cases where SS were highly influential were adjusted R-squared and precision good. Results using these data indicate that the best pre-Results using these data indicate that the oest pre-cision obtainable from regressions will be approxi-mately 50% of the mean value for NaOH-P. This value compares favorably with many other tech-niques. Therefore predicting NaOH-P from regres-sions should be useful for some applications. (Au-

MEASUREMENT AND CHARACTERIZATION OF MACROPORES BY USING AUTOCAD AND AUTOMATIC IMAGE ANALYSIS.

Iowa State Univ., Ames. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W91-09358

PREFERENTIAL SOLUTE TRANSPORT THROUGH MACROPORES IN LARGE UNDIS-TURBED SATURATED SOIL COLUMNS, Iowa State Univ., Ames. Dept. of Agricultural

Engineering.
For primary bibliographic entry see Field 2G.
W91-09359

CLEANER PRODUCTION: THE MOST EFFECTIVE APPROACH TO ACHIEVING IMPROVED WATER QUALITY.

Erasmus Univ., Rotterdam (Netherlands). Studie-centrum voor Millieukunde.

For primary bibliographic entry see Field 5G. W91-09376

DISSOLVED, PARTICULATE AND ACID-LEACHABLE TRACE METAL CONCENTRA-TIONS IN NORTH ATLANTIC PRECIPITATION COLLECTED ON THE GLOBA CHANGE EXPEDITION.

University of East Anglia, Norwich (England). School of Environmental Sciences. For primary bibliographic entry see Field 2B. W91-09381

MODEL OF FATE AND ACCUMULATION OF PCB HOMOLOGUES IN HUDSON ESTUARY. Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program. R. V. Thomann, J. A. Mueller, R. P. Winfield, and

R. V. Thomann, J. A. Mueller, R. P. Winfield, and C.-R. Huang. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 117, No. 2, p 161-178, March/ April 1991. 9 fig, 5 tab, 25 ref, append.

Descriptors: \*Bioaccumulation, \*Estuaries, \*Hudson River, \*Mathematical models, \*Path of pollutants, \*Polychlorinated biphenyls, Food chains, Model studies, Sediment chemistry, Striped

A long-time-scale, large-space-scale model of fate and bioaccumulation of polychlorinated biphenyl (PCB) homologues in striped bass was constructed for the Hudson River estuary. Of the total of 270 Mg (395,000 lb) of PCB discharged to the estuary proper from approximately 1947 through 1987, an estimated 66% volatilized, 6% went to sediment storage, and the remainder was lost by dredging and boundary transport. The striped-bass model indicated that more than 90% of the fish PCB concentration was due to food chain effects. The upstream load from above Troy, New York, was estimated to be contributing 20% to the current

striped-bass PCB concentrations. A no-action alternative indicated that 50% of the 3-6 year, average, striped bass in the mid-Hudson to lower Hudson would be below an action level of 2 microg/g (wet) by about 1992, and 95% by 2004. A simulation of the removal of all upstream PCB loading does not change the time required to reach the 95th percentile because of the increasingly small effect of upstream loading. The principal control action left to accelerate the reduction in striped bass PCB concentration is to control downstream PCB inputs, including sediment releases. stream PCB inputs, including sediment releases.
(Author's abstract) W91-09384

ATERBORNE VIRUSES ASSOCIATED WITH

HEPATITIS OUTBREAK.
Barcelona Univ. (Spain). Facultat de Biologia For primary bibliographic entry see Field 5C. W91-09407

TRIHALOMETHANE FORMATION IN OPEN RESERVOIRS.

Los Angeles City Dept. of Water and Power, CA. A. A. Karimi, and P. C. Singer. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 84-88, March 1991. 8

fig. 9 ref.

Descriptors: \*Algal blooms, \*California, \*Los Angeles, \*Microorganisms, \*Path of pollutants, \*Reservoirs, \*Storage reservoirs, \*Trihalomethanes, \*Water pollution sources, Chlorine, Cyanobacteria, Organic halides, Temporal distribution, Water storage, Water treatment, Nutrient concentrations.

Open treated water reservoirs provide environments suitable for the growth and survival of microorganisms, including algae. Algae release into the water extracellular products (ECP) that serve as trihalomethane (THM) precursors. Silver Lake Reservoir, one of the larger reservoirs in the Los Angeles area, that provides water to the central and east Los Angeles area. has a surface area. Los Angeies area, has provides water to the cen-tral and east Los Angeles areas, has surface area of 76.8 acres, a maximum depth of 39 feet, and a capacity of about 2500 acre-ft. The level of nitrate and the overall concentration of nitrogen are sub-stantially higher in the groundwater than in the surface water, and the phosphorus content is surface water, and the pnosphorus content is higher in the surface water than in the groundwater. Water treatment in the reservoir has consisted largely of applications of copper sulfate and aqueous chlorine for controlling algal growth. The effects of algae, chlorine treatment, and water storage were evaluated on THM and total organic halide (TOX) formation, and the effect of reservations of the control of voir-flow-bypass operation was evaluated on the formation of THMs. Peak THM formation corresponded to peak chlorine application rates, lagging behind by about one month. THM levels near the reservoir (54.4 +/-8.8 microg/L) were on average three to four times greater than the THM levels originally present in the inlet water (16.3 +/-1.1 microg/L). The speciation of THM did not change microg/L). The speciation of THM did not change appreciably. The concentration of TOX also increased at the reservoir outlet, with an average increase of 63.5 microg/L compared with an increase of 9.1 microg/L for THMs. Again, the peak TOX concentrations corresponded with the peak tolorine application rates. The increase in initial THM at the reservoir surface is apparently due to long-term storage of water in the reservoir and chlorination to control seasonal algal growth. Bypassing treated water around the open reservoir. passing treated water around the open reservoir markedly reduced THM formation at the reservoir outlet by about 40%. (Brunone-PTT) W91-09408

PENDIMETHALIN DISSIPATION IN KEN-TUCKY BLUEGRASS TURF.

Nebraska Univ., Lincoln. Dept. of Horticulture. G. K. Stahnke, P. J. Shea, D. R. Tupy, R. N. Stougaard, and R. C. Shearman. Weed Science WEESA6, Vol. 39, No. 1, p 97-103, January/March 1991. 3 fig, 3 tab, 15 ref.

Descriptors: \*Bluegrasses, \*Groundwater pollution, \*Nonpoint pollution sources, \*Path of pollut-

# **Group 5B—Sources Of Pollution**

ants, \*Pendimethalin, \*Pesticides, \*Turf grasses, \*Water pollution sources, Groundwater move-ment, Herbicides, Rainfall, Soil types, Temporal distribution.

Concern for pesticide contamination of ground-water necessitates a determination of fate of pestiwater necessitates a determination of tate of pesti-cides applied to turfgrass. Pendimethalin dissipa-tion was studied following annual 1.7 kg ai/ha applications to three-year-old Kentucky bluegrass turf growing on a Sharpsburg silty clay loam soil and an 85/15 by volume sand/Sharpsburg soil mix-ture in 150-cm-deep rhizotron containers. Plantitissue, thatch, and soil were sampled periodically between application and 168 days after treatment (DAT). Soil and leachate were collected to monitor pendimethalin movement. Most of the herbicide appeared to remain within the turfgrass system. Pendimethalin concentration was highest in plant tissue and thatch. The 4-hydroxymethyl pendimethalin metabolite was detected in turfgrass tissue up to 42 DAT. No pendimethalin was detected at the 30-cm, 60-cm, or 120-cm depths in the water in the rhizotron containers. Traces (<= 0.003 mg/kg) of pendimethalin detected in rhizo-tron leachate collected between 6 and 14 days after heavy rainfall (88 and 95 DAT, respectively) were attributed to gravitational displacement of soil colattributed to gravitational displacement of soil con-loids containing adsorbed herbicide. Pendimethalin application to established turfgrass would not appear to pose a high risk of groundwater contami-nation. (Author's abstract)

MODELLING THE BEHAVIOUR OF OIL SPILLS IN ICE-INFESTED WATERS.

Atmospheric Environment Service, Downsview (Ontario).

S. Venkatesh, H. El-Tahan, G. Comfort, and R. Abdelnour.

Atmosphere - Ocean ATOCDA, Vol. 28, No. 3, p 303-329, 1990. 11 fig, 2 tab, 47 ref, append.

Descriptors: \*Marine pollution, \*Model studies, \*Oil pollution, \*Oil spills, \*Path of pollutants, \*Sea ice, Arctic zone, Floating ice, Grand Banks, Ice cover, Mathematical models, Oceans.

The potential development of oil fields in the Arctic and on the Grand Banks off the Canadian East Coast has brought into focus the need for development of effective countermeasures for oil spills in cold ocean environments. Although numerical models have been developed for prediction of oil spill behavior in open waters, data is lacking concerning oil spills that occur in broken ice cover. This paper describes a mathematical model that will predict the drift and spread behaviour of oil spills in broken ice-infested waters with intermediate (30-80%) to high (>80%) ice concentra-tions. For ice concentrations greater than 30%, the spread of oil is found to drift with the ice in a concentration dependent manner. Equilibrium oil thickness in slush or brash (broken) ice is nearly 4 times that on cold water, which itself is very different from warm water. These empirical data could serve as a basis for developing a more phys-ically oriented theoretical framework for describing oil behaviour in ice water. (D'Agostino-PTT)

**DETERMINATION OF STRONG MUTAGEN, 3-**CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE IN DRINKING

WATER IN JAPAN.
Tokyo Univ. (Japan). Dept. of Urban Engineering. For primary bibliographic entry see Field 5A. W91-09423

CHLORDANE RESIDUES IN GREAT LAKES LAKE TROUT: ACUTE TOXICITY AND INTERACTION AT THE GABA RECEPTOR OF RAT AND LAKE TROUT BRAIN.

RAT AND LAKE TROUT BRAIN.
Michigan State Univ., East Lansing. Pesticide Research Center.
J. W. Gooch, F. Matsumura, and M. J. Zabik.
Chemosphere CMSHAF, Vol. 21, No. 3, p 393-406, 1990. 2 fig. 5 tab, 33 ref. Supported by Michigan Sea Grant number NA84A-D-SG045C, project number R/TS-24, and the Michigan State

University Agricultural Experimental Station.

Descriptors: \*Acute toxicity, \*Chlordane, \*Nervous system, \*Path of pollutants, \*Toxicology, \*Water pollution effects, Animal tissues, Bioassay, Chlorinated hydrocarbon insection Lakes, Pesticides residues, Salmonids. insecticides,

The chlorinated hydrocarbon, chlordane, has been a widely used insecticide since the late 1940's. Because of its extensive application and persistence, chlordane residues can be found in freshwater fish from most U.S. rivers, as well as from the Baltic, the Canadian east coast, the Arctic, and the Battic, the Lanadian east coast, the Arctic, and the Antarctic, making it global chlorinated hydrocar-bon pollutant. In this study, chlordane residue was obtained from tissues of the lake trout, Salvelinus namaycush, obtained from the southern end of namaycush, obtained from the southern end of Lake Michigan and from Siskiwit Lake on Isle Royale in Lake Superior. Residue toxicity was evaluated using both an acute bioassay and a neur-oreceptor binding affinity assay of rat and lake trout brain which showed that the isolated residues were three to five times more toxic than the conwere three to five times more toxic than the control technical mixtures used in agriculture and do-mestic applications. Possibly, this increase is due to the significant abundance of the stable metabolites, heptachlor epoxide and oxychlordane in the residues of complex mixtures. A close correlation was particularly observed between toxicity variation and heptachlor epoxide concentration. Future research may determine if other properties associated with chlordane, such as carcinogenicity, are simi-larly enhanced when present in environmental sources. (D'Agostino-PTT) W91-09424

HIGHLY CARBOXYLATED PORPHYRINS AS A BIOMARKER OF POLYHALOGENATED AROMATIC HYDROCARBON EXPOSURE IN WILDLIFE: CONFIRMATION OF THEIR PRESENCE IN GREAT LAKES HERRING GULL CHICKS IN THE EARLY 1970'S AND IMPORTANT METHODOLOGICAL DETAILS.

Canadian Wildlife Service, Ottawa (Ontario). S. W. Kennedt, and G. A. Fox. Chemosphere CMSHAF, Vol. 21, No. 3, p 407-415, 1990. 3 fig, 2 tab, 22 ref.

Descriptors: \*Bioindicators, \*Gulls, \*Halogenated hydrocarbons, \*Path of pollutants, \*Porphyrins, \*Water pollution effects, Aromatic compounds, Great Lakes, Population exposure, Toxicity, Water birds. Wildlife.

The porphyrias are a group of disorders in which inborn or chemically-induced disturbances of heme biosynthesis results in accumulation and excretion of porphyrin precursors of heme. Correct diagnosis of polyhalogenated aromatic hydrocarbons (PHAHs) requires the demonstration of elevated highly carboxylated porphyrins (HCPs) in tissues and excreta. Using a highly sensitive HPLC method, levels of HCPs in adult herring gull livers obtained from Great Lakes areas have been shown to be elevated as compared to specimens from marine areas. High-performance liquid chromatog-raphy analysis was performed on the porphyrin content of livers collected from Herring Gull chicks (Larus argentatus) from Port Colborne, at the eastern terminus of Lake Erie and Scotch Bonnet Island, in eastern Lake Ontario. The HCPs were elevated in half of the chick livers of Scotch Bonnet Island. Optimal assessment of the extent of Bonnet Island. Opinmal assessment of the extent of wildlife exposure to PHAHs requires both HCP and total porphyrin measurement when porphyria is used as a biochemical marker. (D'Agostino-PTT)
W91-09425

RE-EVALUATION OF CONCENTRATION LEVELS OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN ARTIC SEAL FROM SPITZBERGEN.

Norsk Inst. for Luftforskning, Lillestroem.

M. Oehme, M. Ryg, P. Furst, C. Furst, and H. A.

Chemosphere CMSHAF, Vol. 21, No. 4/5, p 519-523, 1990. 1 fig, 3 tab, 9 ref. Supported by the Norwegian Council for Science and the Humanities, the PROMARE project.

Descriptors: \*Bioaccumulation, \*Chlorinated hydrocarbons, \*Dibenzofurans, \*Dioxins, \*Marine mammals, \*Path of pollutants, \*Svalbard, Arctic zone, Aromatic hydrocarbons, Chlorinated aromatic compounds, Halogenated organic compounds, Halogenated pesticides, Polycyclic aromatic organic compounds. matic organic compounds.

Previously, the concentrations of polychlorinated Previously, the concentrations of polychlorinated dibenzo-p-dioxins (PCDD), dibenzofurans (PCDD), and pesticides in the blubber of 7 ringed seals (Phoca hispida), caught in 1986 at Spitzbergen, had been reported. Additional information, however, regarding sex, age, and exact location of capture were lost. In this study, this information has been regained and the data was re-evaluated. The earlier published levels of PCDD, PCDF, and has been regained and the data was re-evaluated. The earlier published levels of PCDD, PCDF, and some polychlorinated pesticides are in good agreement with other studies of these compounds in Arctic ringed seal. There is no indication that local environmental emissions from the settlement at Ny Alesund, which was much closer to the capture site than originally determined, have influenced or biased the reported concentrations. No influence of sex or age on concentration was found. (D'Agostino-PTT) W91-09427

APPLICATION OF GAS CHROMATOGRA-PHIC TECHNIQUES FOR CHARACTERIZING VAPOR SORPTION ON SOILS: A REVIEW. Florida Univ., Gainesville. Dept. of Soil Science.

R. D. Rhue, and P. S. C. Rao. Chemosphere CMSHAF, Vol. 21, No. 4/5, p 537-556, 1990. 7 fig, 3 tab, 37 ref. Supported by the Electric Power Research Institute, Palo Alto, CA, Contract RP-2879-7.

Descriptors: \*Gas chromatography, \*Path of pollutants, \*Reviews, \*Soil analysis, \*Soil gases, \*Sorption, \*Vapor transport, Adsorption, Land-Separation techniques, Soil contamination, Volatile organic compour

The need to predict the behavior of volatile organic chemicals (VOCs) in the unsaturated zone at landfills and hazardous waste sites has resulted in a resurgence of research on vapor-phase sorption and advective-dispersive transport. Although sev-eral conventional batch equilibrium techniques are available, adapting gas-chromatography (GC) methods for measuring VOC sorption offers numerous advantages, including speed and the ability to make an unlimited number of measurements on to make an unimed number of measurements on the same sorbent. Also, mixtures of VOCs can easily be accommodated with GC methods for competitive sorption effects studies. The present paper reviews the current status of physiochemical measurements by GC, as well as the use of soil for GC columns and water as the liquid phase. Although others have used GC retention data to derive adsorption isotherms for VOCs, questions derive adsorption isotherms for VOCs, questions still remain concerning the reproducibility of these data on different columns and what factors affect isotherms derived from soil columns. Studies to date of VOC sorption on water films using GC have been restricted to relatively high water contents and dilute VOC concentrations (i.e., Henry's region). (D'Agostino-PTT) W91-09428

PCB, PCDD AND PCDF CONCENTRATIONS IN SOILS FROM THE KIRK SANDALL/EDENTHORPE/BARNBY DUN AREA.

Diverse Analyticals Ltd. Manchester (England). I. A. Stenhouse, and K. S. Badsha. Chemosphere CMSHAF, Vol. 21, No. 4/5, p 563-573, 1990. 2 fig, 3 tab, 12 ref. Supported by the Kirk Sandall Action Group.

Descriptors: \*Dibenzofurans, \*Dioxins, \*England, Post-pions: Polencolurais, Plodine, Engand, Incineration, Path of pollutants, Polychlorinat-ed biphenyls, Soil contamination, Water pollu-tion sources, Chemical wastes, Chlorinated aro-matic compounds, Halogenated organic comounds, Polycyclic aromatic organic compounds, Waste disposal.

Considerable public concern exists over the possible environmental impact of toxic emissions from

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chemical waste incinerators. To establish whether any incinerator is causing significant pollution, it is necessary to have baseline concentrations of the relevant pollutants before the start of plant operrelevant pollutants before the start of piant operation. This study present baseline concentrations of polychlorobiphenyls (PCBs), polychlorodibenzo-p-dioxins (PCDBs) and polychlorodibenzo-furans (PCDFs) around the proposed sited for a chemical waste incinerator at Kirk Sandall near Doncaster. England. The results also augment the Doncaster. England. The results also augment the sparse data on urban and rural background levels currently available for these compounds in the UK. The findings show PCB levels between 2 and 11 ppb and 1-TEQ values between 3 and 20 ppt for the dioxins and furans, indicating that, at present, this area has very low contamination levels and is comparable with a rural environment. (D'Agostino-PTT) W91-09429

COSOLVENT EFFECTS ON SORPTION AND MOBILITY OF ORGANIC CONTAMINANTS IN SOILS.

Robert S. Kerr Environmental Research Lab., Ada, OK.

A. L. Wood, P. S. C. Rao. Wood, D. C. Bouchard, M. L. Brusseau, and

P. S. C. Rao. Chemosphere CMSHAF, Vol. 21, No. 4/5, p 575-587, 1990. 6 fig, 15 ref. Supported by a Coopera-tive Agreement, No. CR-814512, between the Uni-versity of Florida and the R. S. Kerr Environmen-tal Research Laboratory, U.S.EPA, Ada, OK.

Descriptors: \*Aromatic compounds, \*Groundwater pollution, \*Hydrophobic compounds, \*Organic solvents, \*Path of pollutants, \*Soil analysis, \*Soil contamination, \*Sorption, Adsorption, Aromatic hydrocarbons, Fate of pollutants, Organic compounds, Polycyclic aromatic organic compounds. pounds, Polycyclic aromatic organic compounds, Separation techniques.

Sources of soil and ground-water contamination at hazardous waste sites often involve complex mixures of hydrophobic organic chemicals (HOCs) and variable amounts of organic cosolvents which can significantly alter the aqueous nature of the subsurface environment. Aqueous systems data, therefore, may be inadequate for describing organtherefore, may be madequate for describing organic contaminant sorption and soil transport of these mixtures. Batch equilibrium and column miscible displacement techniques were used to investigate the influence of the organic cosolvent methanol on the sorption and transport of three HOCs, naptha-lene, phenanthrene, and diuron herbicide, in a sandy surface soil, Eustis fine sand. Equilibrium sorption constant (K) values calculated from batch and column data exhibited an inverse log-linear dependence on the volume fraction of methanol in the mixed solvent. The slope of the plot was approximately equal to the logarithm of the ratio of the HOC solubilities in neat cosolvent and water. K values obtained from breakthrough curves were comparable to those estimated from equilibrium sorption isotherms. Long-term exposure to metha nol-water mixtures had little effect on either soil sorption or transport properties. Column retarda-tion factors were influenced by short-term solvent exposure prior to solute elution. (D'Agostino-PTT) W91-09430

EFFECT OF SUBSTITUTED BENZOPHEN-ONES ON THE PHOTOCHEMICAL FATE OF FENITROTHION INSECTICIDE.

International Atomic Energy Agency, Seibersdorf

(Austria). Labs.

J. Gan, M. Hussain, H. Perschke, and M. N. Rathor.

Chemosphere CMSHAF, Vol. 21, No. 4/5, p 589-596, 1990. 5 fig, 9 ref.

Descriptors: \*Aromatic compounds, \*Fate of pol-lutants, \*Fenitrothion, \*Insecticides, \*Photolysis, \*Soil analysis, \*Soil contamination, Aromatic hy-drocarbons, Groundwater pollution, Insect con-trol, Organic compounds, Polycyclic aromatic or-cenir-compounds ganic compounds

Fenitrothion (O,O-dimethyl O-(4-nitro-m-tolyl) phosphorothioate) is an important insecticide used both in agricultural fields and forests for the con-

trol of chewing and sucking insects and locusts. On exposure to sunlight fenitrothion quickly decom-poses and therefore is short-lived in crops, soils, and in water. Photosensitivity is altered, however, by the presence of other organic chemicals which may reduce or extend its environmental persistence. It was shown that the ultraviolet absorber. ence. It was shown that the ultravioler absorber, Uvinul M-400 (2,4-dihydroxy-benzophenone), pro-vided significant protection to the insecticide from ultraviolet photolysis on soil surfaces and water samples. The degree of protection was concentra-tion dependent and although all the texted com-pounds (M-40, D-49, and MS-40) afforded similar protection, M-400 gave the optimal results. (D'A-gostino-PTT) W91-09431

FLUORIDE-ALUMINIUM WATER CHEMISTRY IN FOREST ECOSYSTEMS OF CENTRAL

Goettingen Univ. (Germany, F.R.). Inst. fuer Bo-denkunde und Waldernachrung. For primary bibliographic entry see Field 5A. W91-09432

CATCHMENT SURVEY FOR HEAVY METALS USING THE EEL (ANGUILLA ANGUILLA), Essex Univ., Colchester (England). Dept. of Biol-

For primary bibliographic entry see Field 5A. W91-09434

PREDICTION OF THE ADSORPTION COEFFICIENT (SUB KOC) FOR SOIL BY A CHEMICALLY IMMOBILIZED HUMIC ACID COLUMN USING RP-HPLC.

National Research Inst. for Radiobiology and Ra-diohygiene, Budapest (Hungary). G. Szabo, S. L. Prosser, and R. A. Bulman. Chemosphere CMSHAF, Vol. 21, No. 6, p 729-

739, 1990. 3 fig, 4 tab, 19 ref.

Descriptors: \*Adsorption, \*Adsorption kinetics, \*Humic acids, \*Path of pollutants, \*Separation techniques, \*Soil chemistry, Aromatic compounds, Correlation analysis, High performance liquid chromatography, Sediment chemistry, Sorption.

Prediction of the movement of anthropogenic substances through soils or sediments and water requires an understanding of the distribution of chemicals between solid and aqueous phases. Using an immobilized humin acid high-performance liquid chromatography (HPLC) phase, a soil adsorption coefficient (KOC) was derived from the HPLC capacity factors (k') determined for a series of aromatic compounds. Both column type and mobile phase composition affected the correlation between log KOC and log k'. This method is superior to other procedures, such as partition into n-octanol and retention on silica-based phases, which have previously been used to model the Prediction of the movement of anthropogenic subwhich have previously been used to model the sorption of aromatic substances on soil or sediment. (D'Agostino-PTT) W91-09436

FIRST VALIDATION OF A MODEL FOR THE ADSORPTION OF LINEAR ALKYLBENZENE-SULFONATE (LAS) TO SEDIMENT AND COM-PARISON TO CHRONIC EFFECTS DATA.

PARISON TO CHRONIC EFFECTS DATA.

Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.

V. C. Hand, R. A. Rapaport, and C. A. Pittinger.

Chemosphere CMSHAF, Vol. 21, No. 6, p 741-750, 1990. 3 tab, 25 ref.

Descriptors: \*Adsorption, \*Alkylbenzene sulfonates, \*Chronic toxicity, \*Model studies, \*Model testing, \*Path of pollutants, \*Sediment chemistry, \*Surfactants, \*Water pollution effects, Aquatic life, Fate of pollutants, Hydrophobic organic compounds, Interstitial water, Mathematical models, Nonionic surfactants, Risk assessment, Sorption.

Available models used to calculate the sorption Available modes used to calculate the solution distribution coefficient (Kd) for hydrophobic organic compounds are well known. However, the adsorption of surfactants, such as linear alkylbenzenesulfonate (LAS), cannot be accurately predictions.

ed by hydrophobic interactions alone. In this study, a model for surfactant sorption proposed by Di Toro is compared to riverine monitoring data for LAS. The model predicts Kd to within one for LAS. In a model predicts Ad to wintin one order of magnitude of measured field values which range from 11 to >24 for sediment/interstitial waters, and from 1000 t0 > 5700 for suspended solids/overlying waters. Also, by enabling prediction of the free concentrations of LAS in sediment interstitial waters, the model provides an interpretive basis for evaluating the safety of monitored LAS concentrations with regard to aquatic organisms. (D'Agostino-PTT) W91-09437

BIODEGRADABILITY AND INHIBITORY THRESHOLD CONCENTRATION OF SOME DISINFECTANTS.

Henkel K.G.a.A., Duesseldorf (Germany, F.R.). P. Gerike, and P. Gode.

Chemosphere CMSHAF, Vol. 21, No. 6, p 799-812, 1990. 1 fig, 1 tab, 25 ref.

Descriptors: \*Biodegradation, \*Disinfectants, \*Fate of pollutants, \*Organic compounds, \*Path of pollutants, \*Toxicity, \*Wastewater treatment, Acetic acid, Alcohols, Aldehydes, Ammonium compounds, Dilution, Halogenated organic com-pounds.

Although the routine use of organic compounds as active ingredients in disinfectants is extremely val-uable, their environmental fate is poorly understood. Twenty five disinfectant raw materials in-cluding alcohols, aldehydes, aldehyde releasing agents, acetic acids, and quaternary ammonium compounds, were examined to determine their biodegradability and possible ecotoxic effects. Many of these constituents are well biodegraded under conditions which prevail in sewage treatment plants and dilution to below their inhibitory threshold concentrations is sufficient for their dependable removal. This implies that, for optimal effect, large volumes must be released in small portions rather than in slug discharges. For ecological protection, therefore, it is necessary to distinguish the biode-gradable organic halogen compounds from those which are environmentally dangerous. (D'Agos-W91-09439

CONTAMINATION OF GROUNDWATER BY ATRAZINE AND SELECTED METABOLITES.
Agricultural Research Service, University Park,
PA. Northeast Watershed Research Center.

H. B. Pionke, and D. W. Glotfelty. Chemosphere CMSHAF, Vol. 21, No. 6, p 813-822, 1990. 1 fig, 3 tab, 21 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural watersheds, \*Atrazine, \*Groundwater pollution, \*Herbicides, \*Path of pollutants, \*Pesticides, \*Triazine herbicides, Agricultural runoff, Metabolites, Pennsylvania, Simazine, Surface-groundwater rela-

The basic concerns about groundwater contamination by the pesticide, atrazine, include possible phytotoxicity of irrigation waters to non-target crops, adverse impact on well water consumers, and toxicity to aquatic organisms. The groundwater contamination patterns of an agricultural watershed in Pennsylvania were determined for atrazine, simazine, and the desethylated (DEA) and desisopropylated (DIA) atrazine metabolites. Atrazine and both metabolites were found in most groundwaters including deep wells, a spring, and ground-waters about to become streamflow. The highest concentrations of atrazine and the dominant meta-bolite, DEA, were found in groundwaters draining areas dominated by corn production, particularly after the first major groundwater recharge period following herbicide application. (D'Agostino-

W91-09440

GROWTH AND SURVIVAL OF BORDETELLA BRONCHISEPTICA IN NATURAL WATERS

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AND IN BUFFERED SALINE WITHOUT ADDED NUTRIENTS.

Glasgow Univ. (Scotland). Dept. of Microbiology. J. F. Porter, R. Parton, and A. Wardlaw. Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 1202-1206, April 1991. 6 fig, 1 tab, 17 ref.

Descriptors: \*Bacterial growth, \*Bordetella, \*Lakes, \*Nutrients, \*Path of pollutants, \*Pathogenic bacteria, \*Ponds, \*Survival, Animal diseases, Buffering, Culture media, Diseases, Escherichia coli, Phosphates, Population density, Seawater.

Bordetella bronchiseptica, a respiratory tract pathogen of animals occasionally isolated from humans, grows on a variety of common solid and liquid bacteriological culture media; however, its growth in fluids with low concentrations of nutrients has not previously been reported. In the present study, B. bronchiseptica showed increases in viable count when incubated in phosphate-buf-fered saline (PBS), in reagent-grade water, and in local lake and pond waters, all without added nutrients. Within 48 to 72 h at 37 C in PBS and in lake and pond waters, stationary-phase populations of around 2.7 million CFU/ml developed from washed B. bronchiseptica inocula of around 2,000 CFU/ml. Increases in CFU on the order of 5-fold and 8-fold, respectively, were observed in reagent grade water and in seawater from the same sizes of inocula. The organisms remained viable for at least 3 weeks in PBS and in lake waters at 37 C. The possibility that carryover of nutrients was responsible for growth was discounted by showing serial transfer of B. bronchiseptica in PBS under conditions in which Escherichia coli tested in parallel rapidly died out. Whether B. bronchiseptica expresses its virulence factors when grown under the low-nutrient conditions of lake water or PBS in low-nutrient conditions of lake water or PBS in unknown. However, the fact that it can grow and survive in such liquids means that it may occur as a free-living organism in addition to its role as a mammalian pathogen. There may therefore be reservoirs of B. bronchiseptica infection in natural fresh and salt waters. (Doria-PTT)
W91-09448

MASS TRANSPORT IN THE DISTRIBUTED SOURCE MODELING AQUIFERS: PROBLEM.

Kentucky Water Resources Research Inst., Lex-

Serrano. Available from National Technical Information Available from National Technical Information Service, Spring, ield, VA 22161 as PB91-111542/ AS. Price codes: A07 in paper copy, A07 in micro-fiche. Research Report No. 176, August 1990. 133p, 28 fig, 99 ref. USGS Contract No. 14-08-0001-G1564.

Descriptors: \*Aquifers, \*Distributed sources, \*Forecasting, \*Groundwater movement, \*Groundwater pollution, \*Mass transfer, \*Mathematical models, Model studies, Path of pollutants, Statistical studies, Stochastic models, Water pollution

A new methodology to model the time and space evolution of groundwater variables in a system of aquifers when certain components of the model, such as the geohydrologic information, the bound-ary conditions, the magnitude and variability of the sources or physical parameters are uncertain and defined in stochastic terms. This facilitates a more realistic statistical representation of groundwater flow and groundwater pollution forecasting for either the saturated or the unsaturated zone. The method is based on applications of modern mathematics to the solution of the resulting stochastic transport equations. This procedure exhibits considerable advantages over the existing stochastic modeling techniques. In particular, the semigroup solutions are not restricted to small variances in the stochastic elements (perturbation techniques), un-steady dynamic conditions are specifically considered, time and space randomness may be considered in the sources, the boundary conditions or the ered in the sources, the boundary conditions of the parameters, and the methodology reflects as well-posed functional-analytical theory. Several basic example problems are presented in order to illus-trate the application of the methodology to the

modeling of complex spatially and temporally distributed sources of interest in engineering hydrology. Further potential applications of the method are promising, including the modeling of non-conservation contaminants in groundwater systems. (Huffsey-U. Ky., WRRI) W91-09471

CHEMICAL, GEOLOGIC, AND HYDROLOGIC DATA FROM THE STUDY OF ACIDIC CON-TAMINATION IN THE MIAMI WASH-PINAL CREEK AREA, ARIZONA, WATER YEARS

Geological Survey, Tucson, AZ. Water Resources

J. G. Brown. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-395, 1990. 75p, 2 fig. Project

Descriptors: \*Acid mine drainage, \*Arizona, \*Groundwater pollution, \*Hydrologic data, \*Pinal Creek, \*Water quality, Chemical analysis, Globe, Particle size, Precipitation data, Stream pollution.

Hydrologic, geologic, and water-quality data have been collected since 1984 as part of a U.S. Geological Survey study of the occurrence and movement of acidic contamination in the aquifer and streams of the Pinal Creek basin Globe, Arizona. Groundwater data from that study are presented for water years 1988 and 1989 and include location, construction information, site plans, water levels, and chemical analyses of water samples for seven groups of monitoring wells. Also included are min-eralogic and particle-size analyses of drill cuttings from four wells. Surface-water data are presented for four sites and include discharge measurements and chemical analyses of water. Monthly discharge data are presented for one site. Monthly precipitation data and long-term precipitation statistics are presented for two sites. (USGS) W91-09486

EFFECTS OF STORM RUNOFF ON WATER QUALITY IN THE WHITE RIVER AND FALL CREEK, INDIANAPOLIS, INDIANA, JUNE THROUGH OCTOBER 1986 AND 1987.

Geological Survey, Indianapolis, IN. Water Resources Div.

Sources Div.

J. D. Martin, and R. A. Craig.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Water-Resources Investigations Report 89-4185, 1990. 114p, 42 fig, 38 tab, 44 ref, append.

Descriptors: \*Nonpoint pollution sources, \*Storm runoff, \*Urban hydrology, \*Urban runoff, \*Water pollution sources, Combined sewer overflows, Dissolved oxygen, Monitoring.

Four continuous, flow-through water-quality montiors were installed upstream from, in, and down-stream from Indianapolis on the White River and near the mouth of Fall Creek in Indianapolis to monitor water quality, especially dissolved oxygen, during periods of base flow and storm runoff. Streamflow, dissolved-oxygen concentrarunoff. Streaminow, unsolved-oxygen concentra-tion, specific conductance, PH, and water tempera-ture were measured at 15-minute intervals from June through October 1986 at the four sites and from June through October 1987 at two sites. Concentrations of dissolved oxygen ranged from 1.0 to 20.4 mg/L, specific conductance ranged from 161 to 1,400 microsiemens/centimeter at 25 from 161 to 1,400 microsiemens/centimeter at 25 C, pH ranged from 6.6 8.9, and temperature ranged from 9.8 to 30.4 C during the study period. Supersaturation of dissolved oxygen greater than 200% commonly occurred in the White River, but rarely exceeded 150% in Fall Creek. Photosynthesis caused the large fluctuations and supersaturation of dissolved oxygen, and indicates that the White River is more productive than Fall Creek. Water quality during base flow is the typical condition against which water quality during storm runoff is against which water quanty auring storm rution is compared. A rapid increase in streamflow indicates the beginning of a period of storm runoff and is associated with a decrease in specific conductance and pH and, dissolved oxygen or temperature. Concentrations of dissolved oxygen often de-

creased during storm runoff, especially during the initial rise in the hydrograph. Storm runoff consistently diminished or eliminated daily cycles of dis-solved oxygen. Minimum concentrations during 12 solved oxygen, minimum concentrations uting 12 clow dissolved-oxygen periods of storm runoff. Minimum concentrations during twelve low dissolved-oxygen periods ranged from 1.0 to 3.9 mg/L, and had a median concentration of 2.8 mg/L. Durations of low dissolved-oxygen concentrations ranged from .75 to 83.75 hours and had median durations of five hrs. Minimum concentrations durations of tive firs. Minimum concentrations during five low dissolved-oxygen periods at Fall Creek ranged from 2.0 to 3.4 mg/L and had a median concentration of 2.7 mg/L. Duration of low dissolved-oxygen concentrations ranged from 1.75 to 33.75 hrs and had a median duration of 7 her (1963). hrs. (USGS) W91-09495

ASSESSMENT OF GROUND-WATER CONTAMINATION FROM A LEAKING UNDERGROUND STORAGE TANK AT A DEFENSE SUPPLY CENTER NEAR RICHMOND, VIR-GINIA.

Geologic al Survey, Richmond, VA. Water Resources Div.

J. D. Powell, and W. G. Wright.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4091, 1990. 38p, 13 fig, 11 tab, 13 ref.

Descriptors: \*Gasoline, \*Groundwater pollution, \*Monitoring, \*Underground storage, \*Water pollution sources, Geohydrology, Groundwater movement, Virginia.

During 1988-89, 24 wells were installed in the vicinity of the post-exchange gasoline station on the Defense General Supply Center, near Richmond, Virginia, to collect and analyze groundwatmond, Virginia, to collect and analyze groundwat-er samples for the presence of gasoline contamina-tion from a leaking underground storage tank. Concentrations of total petroleum hydrocarbons and benzene were as high as 8.2 mg/L and 9,000 microg/L, respectively, in water from wells in the immediate vicinity of the former leaking tank, and benzene concentrations were as high as 2,300 microg/L in a well 600 ft down gradient from the gasoline station. Groundwater flow rates are estimated to be about 60 to 80 ft/yr; on the basis of these flow rates, the contaminants may have been introduced into the groundwater as long as 7-10 yrs ago. Groundwater might infiltrate a subsurface storm sewer, where the sewer is below the water table, and discharge into a nearby stream. Prelimi-nary risk assessment for the site identified no potential human receptors to the groundwater con-tamination because there were no groundwater users identified in the area. Remediation might be appropriate if exposure of future potential users is a concern. Alternatives discussed for remediation of groundwater contamination in the upper aquifer at the PX Service Station include no-action, soil vapor extraction, and groundwater pumping and treatment alternatives. (USGS) W91-09497

HYDROLOGICAL, METEOROLOGICAL AND GEOHYDROLOGICAL DATA FOR AN UN-SATURATED ZONE STUDY NEAR THE RA-DIOACTIVE WASTE MANAGEMENT COM-PLEX, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO--1987. Geological Survey, Idaho Falls, ID. Water Re-

sources Div.

For primary bibliographic entry see Field 2F. W91-09499

RADIONUCLIDES, METALS, AND ORGANIC COMPOUNDS IN WATER, EASTERN PART OF A&B IRRIGATION DISTRICT, MINIDOKA COUNTY, IDAHO. Geological Survey, Idaho Falls, ID. Water Resources Div.

L. J. Mann, and L. L. Knobel.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-191, 1990. 36p, 2 fig, 16 tab,

# Sources Of Pollution-Group 5B

22 ref. Contract No. DE-AI07-81ID12306. Project

Descriptors: \*Data collections, \*Groundwater, \*Idaho, \*Radioactive wastes, \*Water pollution sources, \*Water quality, Chemical analysis.

The U.S. Geological Survey, in response to a U.S. Department of Energy request, collected and analyzed water samples from 15 sites in Minidoka County, Idaho. Samples were collected from 12 groundwater and 3 irrigation wastewater sites. Samples were analyzed for tritium, gross alphaparticle and beta-particle radioactivity, total urani-um, radium, radon-222, strontium-90, gross gamma radioactivity, trace metals, purgeable organic com-pounds, nutrients, and pesticides. Tritium concenpounds, nutrients, and pesticides. Tritium concentrations were determined by U.S. Geological Survey, U.S. Department of Energy, and Idaho State University laboratories. Seven samples had tritium concentrations larger than the reporting level, ranging from 0.045 +/-0.013 to 0.106 +/-0.013 pc/mL (piccouries/ml). Ranges of dissolved concentrations for some other radionuclides or types of radioactivity follow: gross alpha-particle radioactivity as thorium-230-2.23 +/-0.61 to 9.10 +/-1.25 pc/U. (piccouries/ml), gross leb to cle radioactivity as thorium-230-2.23 +/-0.61 to 9.10 +/-1.25 pCi/L (picocuries/L); gross beta-particle radioactivity as strontium-90 in equilibrium with yttrium-90-2.50 +/-1.28 to 10.3 +/-2.5 pCi/L; total uranium-1.38 +/-0.16 to 5.22 +/-1.02 microg/L; radium-226-0.0102 +/-0.0064 to 0.149 +/-0.024 pCi/L; and strontium-90-from < the reporting level to 0.483 +/-0.071 pCi/L. The uncertainties are two sample standard deviations (2s) except tritium, which is 1s. Concentrations of nitrie plus nitrate as nitrogen ranged from 0.94 to 5 trite plus nitrate as nitrogen ranged from 0.94 to 5 mg/L. Tetrachloroethylene (0.2ug/L) and benzene (0.2ug/L) were present in water from an irrigation drain. Water from three irrigation drains contained concentrations of 2,4-D ranging from 0.02 to 0.27 ug/L. Carbofuran, fonofos, dieldrin, aldicarb, diuron, bromacil, a phenylurea-like compound, diazinon, and malathion were present in one or more water samples--mostly from the irrigation drains-at small concentrations. (USGS) W91-09501

EFFECTS OF AROMATIC CONCENTRATION ON METHANE FERMENTATION.
Kentucky Water Resources Research Inst., Lex-

For primary bibliographic entry see Field 5D. W91-09503

METAL SPECIATION AND IMMOBILIZA-TION REACTIONS AFFECTING THE TRUE EFFICIENCY OF ARTIFICIAL WETLANDS TO TREAT ACID MINE DRAINAGE. Water Resources Research Inst., Lex-Kentucky

ington

ington.
A. D. Karathanasis, and Y. L. Thompson.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-107300/
AS. Price codes: AO7 in paper copy, AO7 in microfiche. Research Report No. 175. August 1990.
120p. 35 fig, 51 tab, 41 ref, 2 append. USGS
Contract No. 14-08-0001-G1546. USGS Project
no. G1564-02 (A-112KY).

Descriptors: \*Acid mine drainage, \*Metals, \*Toxins, \*Water pollution treatment, \*Wetlands, Aluminum, Copper, Ecosystems, Inorganic metal species, Iron, Kentucky, Manganese, Organometals, Zinc.

The ability to construct wetlands to lower total metal concentrations and organically complex metals in acid mine drainage (AMD) was investi-gated under greenhouse and field conditions. In the greenhouse study. Typha plants grown in six dif-ferent substrates received simulated acid mine drainage of low metal load for five months. Most effluents, especially those from ground flows, showed significant decreases in acidity and metal concentrations. The pine needle and hay substrates most effectively reduced acidity and total Al levels. Effluents from these substrates contained levels. Effluents from these substrates contained 80% less total Al than respective influents. Organically complexed Al levels were independent of matrix and varied from 10 to 30% of total Al inflow concentrations. Peat and Sphagnum moss

most efficiently reduced Fe concentrations but only 10% of the total Fe was organically com-plexed. Matrix composition had little or no effect on Mn concentrations. Substrates lowered Cu and Zn levels by 40-90% in most effluents, but pine needle and hay mixtures were the most effective. The metal concentration and acidity of a very high metal load AMD were also reduced substantially during the first six months of treatment with a wetland which was constructed by the U.S. Forest Service in McCreary County, KY and used mushroom compost as a substrate. After 8 months of operation, however, and during periods of high flow rate (10 gal/min) the efficiency of the wetland was drastically reduced. The majority of Fe. land was drastically reduced. The majority of Fe, Mn, and Zn in surface effluents was present in inorganic metal species. Nearly 100% of Cu and about 40% of Al, however, was organically bound. A great portion of the metals retained by the greenhouse and field substrates was in residual forms (oxyhydroxides, sulfides, sulfates, carbonates). The metals Fe, Mn, and Zn showed the highest tendency for residual retention, while Al and especially Cu showed high affinity for organic retention. Exchangeable and sorbed forms were present in very small concentrations and in many cases were almost negligible. (Huffsey-Univ KY, KWRRI)

USE OF ELUTRIATE TESTS AND BOTTOM-MATERIAL ANALYSIS IN SIMULATING DREDGING EFFECTS ON WATER QUALITY OF SELECTED RIVERS AND ESTUARIES IN OREGON AND WASHINGTON, 1980-83. Geological Survey, Portland, OR. Water Resources Div.

G. J. Fuhrer, and D. Evans.

G. J. Funrer, and D. Evans. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4051, 1990. 54p, 4 fig, 19 tab, 1 pl, 61 ref.

Descriptors: \*Bottom sediments, \*Dredging, \*Environmental impact, \*Water pollution sources, Model studies, Oregon, Organic pesticides, Trace metals, Washington

Native waters, elutriate-test filtrates, and bottom materials were analyzed for selected trace metals and organic compounds listed in the U.S. Environand organic compounts its ten in the U.S. Environ-mental Protection Agency priority pollutant list, prior to dredging and disposal activities. A single reconnaissance sampling was made at several sites located in 17 rivers and estuaries, from 1980 to 1983, in an area that extends south to the Coos-ticus in waters. Crease north to Baker Bayes river in western Oregon; north to Baker Bay in southwest Washington; east to the Willamette River near Portland, Oregon; and west to the Pacific Ocean. Copper, iron, lead, manganese, and can be compared to the pacific Ocean. Copper, iron, lead, manganese, and zinc were the only trace metals detected in about 50% of the native-water samples. In contrast, arsenic, cadmium, copper, iron, manganese, mercury, nickel, and zinc were detected in about 50% of the elutriate-test filtrates. Organochlorine compounds examined in alutriate-test filtrate generally were below analytical detection limits. The organochlorine compounds dieldrin, endosulfan, endrine, heptachlor, and lindane were detected in 25% of neptacinor, and indiane were detected in 25% of the bottom-material samples. Concentrations of ammonia, beryllium, cadmium, copper, manganese, and mercury were the only chemicals found to exceed aquatic life criteria in elutriate-test filtrate. Beryllium and copper concentrations were local-ized to the Astoria and Skipanon project areas, respectively. Cadmium concentrations exceeding U.S. Environmental Protection Agency criteria occurred near the mouth of the Columbia River. (USGS) W91-09524

CONCENTRATIONS OF METALS IN BED MA-TERIAL IN THE AREA OF CONGAREE SWAMP NATIONAL MONUMENT AND IN WATER IN CEDAR CREEK, RICHLAND COUNTY, SOUTH CAROLINA.
Geological Survey, Columbia, SC. Water Re-

sources Div. T. W. Cooney.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Open-File Report 90-370, 1990. 25p, 2 fig, 5 tab, 9

Descriptors: \*Congaree Swamp National Monu-ment, \*Sediment contamination, \*South Carolina, \*Trace metals, \*Water pollution sources, Cedar Creek Toms Creek

The occurrence of trace metals in bed material has been determined in the area of the Congaree Swamp National Monument and in the surface water of a major tributary, Cedar Creek. The study was prompted by concern that trace metals in this valuable floodplain ecosystem could contaminate and endanger plant and animal life. A total of 37 bed-material samples were collected at 28 stations during two periods (June 18, 1985, and May 28 to June 5, 1986). Analyses of the samples indicated barium, iron, magnesium, and manga-nese, which occur naturally in soils in the basins, are present in a wide range of concentrations in the Cedar Creek and Toms Creek watersheds. The highest observed concentrations were 400; 68,000; 35,000; and 1,700 micrograms/g, respectively. Be-ryllium, cadmium, lithium and molybdenum were, if present, in concentrations no greater than mini-mum detection levels. Overall, concentrations of the metals in the Cedar Creek watershed are sig-nificantly higher than in the Toms Creek watershed. Relatively high concentrations in samples outside the influence of either Cedar Creek or Toms Creek indicate that the flood plain may act as a sink for certain metals. Ten surface water samples collected at a site on Cedar Creek were analyzed for trace metals. Concentrations of ca mium, a highly toxic metal, equaled or exceeded the U.S. Environmental Protection Agency drink-ing-water maximum contaminant level of 10 microgram/L in three samples, with the highest concentration observed being 15 microgram/L. Concentrations of manganese equaled or exceeded the drinking-water secondary maximum contaminant level of 50 micrograms/L in seven samples, with the highest observed concentration being 220 mithe ingnest observed concentration being 220 mi-crograms/L. Copper, zinc, and lead were found in concentrations less than the drinking water second-ary maximum contaminant level, with the highest observed concentrations being 51,270, and 35 mi-crograms/L, respectively. Concentrations of barjum, beryllium, chromium, cobalt, lithium, and molybdenum were, if present, equal to or less than the minimum detection levels. (USGS) W91-09533

GEOHYDROLOGY, GROUND-WATER QUALITY, AND SIMULATED GROUND-WATER FLOW, GEAUGA COUNTY, OHIO.

Geological Survey, Columbus, OH. Water Resources Div. For primary bibliographic entry see Field 2F.

W91-09534

GEOLOGIC SOURCES, MOBILIZATION, AND TRANSPORT OF SELENIUM FROM THE CALIFORNIA COAST RANGES TO THE WESTERN SAN JOAQUIN VALLEY: A RECONNAISSANCE STUDY.

Geological Survey, Menlo Park, CA. Water Resources Div.

T. S. Presser, W. C. Swain, R. R. Tidball, and R. C. Severson.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4070, December 1990. 66p, 10 fig, 18 tab, 122 ref.

Descriptors: \*Geochemistry, \*Kesterson Wildlife Refuge, \*Path of pollutants, \*Selenium, \*Water pollution effects, \*Water pollution sources, Arid-zone hydrology, Minerals, Salts, Shales, Subsur-face drainage, Weathering.

Studies of ecological damage at Kesterson National Wildlife Refuge in the western San Joaquin Valley, California, have implicated enrichment of the trace element selenium and increased salinity in subsurface gricultural drainage waters as major factors. Through reconnaissance sampling of waters, evaporative salts, soils, and bedrock from a geologically diverse 1,000-sq mi area, that encom-

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passes 11 Coast Range basins draining into the western valley, the mobility of selenium has been traced and a conceptual model developed. In the study area, elevated concentrations of selenium are seen in the extensive surficial exposures of the shales of the Upper Cretaceous-Paleocene Moreno and Eocene-Oligocene Kreyenhagen Formations which provide the primary sources of selenium to the west-central valley. Alternative source materials investigated, including Cretaceous and Tertiary sandstones, Pliocene-Pleistocene continental rocks, sandstones, Pilocene-reistoche confinenta focus, acid mine drainage from New Idria Mercury Mining District and waters from the eugeosynclinal Franciscan assemblage and serpentinites, are comparatively barren of selenium. Selinium is mobilized by oxidative weathering of these pyritic shales as evidenced by characteristic pH 4 seeps and shade the contractive of the seeps of the see and abundant evaporative sodium and magnesium sulfate salts. The selenate form of selenium is con-centrated in these soluble salts, which act as temporary geologic sinks. Theoretically, the open lat-tice structures of these hydrous minerals could incorporate the selenate anion in the sulfate space. When coupled with an arid climate, fractional crystallization and evaporative concentration can occur creating a sodium-sulfate fluid that exceeds the U.S. Environmental Agency limit of 1,000 microgram/L for a toxic selenium waste. (USGS) W91-09535

GOVERNING EQUATIONS AND MODEL AP-PROXIMATION ERRORS ASSOCIATED WITH THE EFFECTS OF FLUID-STORAGE TRAN-SIENTS ON SOLUTE TRANSPORT IN AQUIFERS. Geological Survey, Reston, VA. Water Resources Div

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4156, 1990. 20p, 4 fig, 6 ref.

Descriptors: \*Aquifers, \*Groundwater movement, \*Model studies, \*Path of pollutants, \*Solute transport, \*Unsteady flow, Advection, Computer models, Differential equations, Groundwater polluments, Groundwater movement, \*\*Solution of Gro tion, Mathematical models, Storage coefficient, Traveltime, Velocity, Water table fluctuations.

During transient groundwater flow, the fluid mass/unit volume of aquifer changes as the poten-tiometric head changes, and solute transport is affected by this change in fluid storage. Three widely applied numerical models of two-dimensional transport incorporate the effects of transient flow on solute transport by removing redundant flow-equation terms from the transport equation. However, in certain circumstances fluid-storage terms remaining in the transport equation are erroneously held constant in these models. For the case of increasing heads, this appropriation leads to of increasing heads, this approximation leads to velocities that are too high and reduced dilution at fluid and solute sources. These errors are quanti-fied by means of two simple analytical examples and a numerical simulation. In some cases, the errors induced in transport simulations by ignoring temporal changes in fluid-storage terms are comparable to the errors from assuming steady-state flow. Errors in source calculations are generally smaller than errors in flux terms. During transient flow in water-table aquifers, solute transport may be affected more by changing fluid storage than by changes in transmissivity due to saturated thickness changes. For conceptual models that are based on the assumption of constant fluid density, the prodthe assumption of constant ruid density, the product of porosity and aquifer thickness changes in time: initial porosity times thickness plus the changes in head times the storage coefficient. This formula reduces to the saturated thickness in water-table aquifers if porosity is assumed to be equal to the storage coefficient. (USGS) W91-09537

WATER-RESOURCES ACTIVITIES IN UTAH BY THE U.S. GEOLOGICAL SURVEY, OCTO-BER 1, 1988, TO SEPTEMBER 30, 1989,

Geological Survey, Salt Lake City, UT. Water

Resources Div. For primary bibliographic entry see Field 7C. W91-09540

SHALLOW GROUND WATER IN THE WHIT-NEY AREA, SOUTHEASTERN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA--PART I. DESCRIPTION OF CHEMICAL QUALITY, 1986-87.

Geological Survey, Carson City, NV. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09542

SELECTED FACTORS RELATED TO THE PO-TENTIAL FOR CONTAMINATION OF THE PRINCIPAL AQUIFER, SALT LAKE VALLEY,

Geological Survey, Salt Lake City, UT. Water For primary bibliographic entry see Field 2F. W91-09544

EFFECTS OF STORM-WATER RUNOFF ON LOCAL GROUND-WATER QUALITY, CLARKSVILLE, TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4044, 1991, 57p, 13 fig, 7 tab, 21 ref.

Descriptors: \*Clarksville, \*Drainage wells, \*Karst, \*Path of pollutants, \*Tennessee, \*Urban runoff, \*Water pollution sources, \*Water quality, Sinks, Surface-groundwater relations, Trace metals.

Water-quality data were collected at a drainagewell site and at a spring site in Clarksville, Tennes-see, to define the effects of storm-water runoff on the quality of groundwater in the area. A dye-trace test verified the direct hydraulic connection between the drainage well and Mobley Spring. Samples of storm runoff and spring flow were collected at these sites for nine storms during the period February to October 1988. Water samples also were collected from two other springs and two observation wells in the area during dry-weather conditions to assess the general quality of ground-water in an urban karst terrane. Concentrations and loads for most major constituents were much and loads for most major constituents were much smaller in storn—water runoff at the drainage well than in the discharge of Mobley Spring, indicating that much of the constituent load discharge from the spring comes from sources other than the drainage well. However, for some of the minor constituents received with read-unity the society of the state of the society of the state o constituents associated with roadway runoff (arconstituents associated with foadway funding (ar-senic, copper, lead, organic carbon, and oil; and grease), the drainage well contributed relatively large percentages (22% to 75%) of the loads of tage percentages (22% of 73%) of the foats of these constituents discharged at the spring. For the period February to October 1988, estimated loads of lead and organic carbon entering the drainage well totaled 0.45 and 660 pounds, respectively. (USGS) W91-09550

TRITIUM IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORA-Geological Survey, Idaho Falls, ID. Water Re-

sources Div.

L. J. Mann, and L. D. Cecil.

L. J. Mann, and L. D. Cecil. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4090, 1990. 35p, 10 fig, 2 tab, 19 ref. Contract No. DE-AI07-81ID12306. Project No. ID-165.

Descriptors: \*Groundwater recharge, \*Idaho National Engineering Laboratory, \*Path of pollutants, \*Tritium, \*Wastewater disposal, \*Water pollution sources, Idaho, Water quality.

Approximately 30,900 curies of tritium were con-Approximately 30,900 curies of tritium were contained in wastewater generated from 1952 to 1988 by ICPP (Idaho Chemical Processing Plant) and the TRA (test Reactor Area) at the Idaho National Engineering Laboratory. The wastewater disposed at the ICPP was discharged directly to the Sanke River Plain aquifer through a disposal well until February 9, 1984, when routine use of the well was

discontinued and the use of an unlined infiltration pond was begun. A second pond was put into use on October 17, 1985. Wastewater disposed at the on October 17, 1985. Wastewater disposed at the TRA has been discharged to one to three infiltration ponds since 1952. The average annual concentration of tritium in water from 26 selected wells at the INEL decreased from 250 pCi/mL (picocuries/milliliter) in 1961 to 18 pCi/mL in 1988, a decrease of about 93%. The maximum tritium concentration was 844+ or-5 pCi/mL in 1961 and was 61.6+ or-1.1 pCi/mL in 1988. Four factors are responsible for this decrease in tritium concentration. (1) a decrease in the amount of tritium dispersion. tion: (1) a decrease in the amount of tritium disposed annually to ponds and wells from 1961 to 1988; (2) the change from the use of a disposal well to infiltration ponds; (3) radioactive decay; and (4) dilution from recharge. (USGS) W91-09553

WATER-RESOURCES POTENTIAL OF THE FRESHWATER LENS AT KEY WEST, FLORI-

Geological Survey, Miami, FL. Water Resources

D. J. McKenzie.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4115, 1990. 24p, 18 fig, 5 tab, 28 ref. Project No. FL-446.

Descriptors: \*Florida, \*Groundwater pollution, \*Key West, \*Water pollution sources, Freshwater lens, Island hydrology, Landfills, Water quality.

The island of Key West receives its public-water supply from the Florida Keys Aqueduct Authority Well Field near Miami and from privately owned wells on the island that tap the local fresh groundwater lens. The lens averages 5 ft in thickness below the center of the western half (Old Town) of the island. The lens contains about 20 to 30 million gallons of freshwater, depending on rainfall recharge. The water is a calcium bicarbonate type that grades to a sodium chloride type because of saltwater intrusion and mixing. Elevated concentrations of nitrate were found in water samples from wells in the Old Town district. However, concentrations generally were not above the maximum contamination level established by the Florida Department of Environmental Regulation. Mater samples near an old landfill on the eastern half of the island had concentrations of iron (600-1,900 micrograms/L) and lead (40-800 micrograms/L) that exceeded the maximum contaminant levels of 300 and 50 micrograms/L. These trace-element concentrations generally decreased with distance from the landfill. (USGS)

TREND ANALYSIS OF SELECTED WATER-QUALITY CONSTITUENTS IN THE VERDE RIVER BASIN, CENTRAL ARIZONA.

Geological Survey, Tucson, AZ. Water Resources

5. DatQS.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4128, 1990. 55p, 19 fig, 5 tab, 25 ref. Project No. AZ105-619 (88896).

Descriptors: \*Arizona, \*Statistics, \*Verde River, \*Water pollution sources, \*Water quality, Rivers, Time series analysis, Water quality trends.

Temporal trends of eight water quality constituents at six data collection sites in the Verde River basin in central Arizona were investigated using seasonal Kendall tau and ordinary least-squares regression methods of analysis. The constituents are dissolved solids, dissolved sulfate, dissolved are dissolved solids, dissolved sulfate, dissolved arsenic, total phosphorus, pH, total nitrite plus nitrate-nitrogen, dissolved iron, and fecal coliform bacteria. Increasing trends with time in dissolved solids concentrations of 7 to 8 mg/L/yr at Verde River near Camp Verde were found at significant level (p < or = 0.0500). An increasing trend in dissolved-sulfate concentrations of 3.59 mg/L/yr was also found at Verde River near Camp Verde, when the property leaves (x = 0.2660). although at nonsignificant levels (p = 0.2609).

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Statistically significant decreasing trends with time in dissolved-solids and dissolved-sulfate concentrations were found at Verde River above Horseshoe tions were found at Verde River above Horseshoe Reservoir, which is downstream from Verde River near Camp Verde. Observed trends in the other constituents do not indicate the emergence of water quality problems in the Verde River basin. Analysis of the eight water quality constituents generally indicate nonvarying concentration levels after adjustment for seasonality and streamflow were made (USGS). were made. (USGS) W91-09555

LONG-TERM EFFECTS OF SURFACE COAL MINING ON GROUND-WATER LEVELS AND QUALITY IN TWO SMALL WATERSHEDS IN EASTERN OHIO.

Geological Survey, Columbus, OH. Water Resources Div.
W. L. Cunningham, and R. L. Jones.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4136, 1990. 74p, 42 fig, 3 tab, 13 ref.

Descriptors: \*Coal mining, \*Geohydrology, \*Mine effects, \*Ohio, \*Strip mines, \*Water pollution sources, Groundwater level, Time series analysis,

Two small eastern Ohio watersheds surface mined for coal and reclaimed were studied during 1986-107 Cold and Canada Water quality data were compared with data from investigations conducted during 1976-83 to determine long-term effects of surface mining on the hydrologic system. Before mining, the watersheds were characterized by flatlying sedimentary rocks above clay beds underly-ing two major coal seams. Two aquifers overlay each underclay. Surface mining removed the upper aquifer, stripped the coal seam, and replaced the spoil, creating a new aquifer with hydraulic and chemical characteristics different from those of the continuously in one well in each aquifer and every 2 months in other wells. Water levels in upper aquifers reached hydraulic equilibrium from 2 to 5 years after mining and, in middle aquifers, water levels increased more than 5 ft during mining; equilibrium occurred almost immediately thereafter. Water samples were collected from the equilibrium occurred almost immediately thereaf-ter. Water samples were collected from three upper aquifer wells, one middle-aquifer well, a seep from the upper aquifer, and the stream in each watershed. Samples were collected in 1986, 1987, 1988, and 1989. In both watersheds, sulfate re-placed bicarbonate as the dominant anion in the upper aquifer after mining. In general, signific (locally, more than an order of magnitude) in-(locally, more than an order of magnitude) increases in concentrations of dissolved constituents in groundwater resulted from surface mining. The continued decrease in pH indicates that groundwater had not reached complete geochemical equilibrium in either watershed more than 8 years after mining ended. (USGS)
W91-09556

GLEAMS MODEL--A TOOL FOR EVALUATING AGRICHEMICAL GROUND-WATER
LOADING AS AFFECTED BY CHEMISTRY,
SOILS, CLIMATE AND MANAGEMENT.
Agricultural Research Service, Tifton, GA.
R. A. Leonard, W. G. Knisel, and F. M. Davis.

In: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 187-197. 4 fig, 1 tab, 19 ref.

Descriptors: \*Computer models, \*Leaching, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutiants, \*Pesticides, \*Runoff, \*Water pollution sources, Agricultural chemicals, Computpontution sources, Agricultural chemicals, Computer er programs, Computers, Erosion, GLEAMS model, Groundwater, Irrigation requirements, Land management, Mass transport, Rainfall, Root zone, Simulation, Soil properties, Soil water, Technology transfer.

The GLEAMS model (Groundwater Loading Effects of Agricultural Management Systems) was developed as an extension of an earlier USDA model, CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems).

Both models simulate soil water balance and surboth models stimulate soil water balance and sur-face transport of sediments and chemicals from agricultural field management units. GLEAMS, also simulates chemical transport in and through the plant root zone. Several other features were the plant root zone. Several other features were added such as irrigation/chemigation options, pesticide metabolite tracking, and software to facilitate model implementation and output data analysis. Because of its comprehensiveness, ease of implementation and user support, GLEAMS is widely used by researchers, state and federal agencies responsible for water quality programs, the agrichemical industry, and others. Input requirements for the model include daily rainfall volumes, care and management parameters; soil and physicare and management parameters; soil and physical desired and services and management parameters; soil and physical desired and services and management parameters; soil and physical desired and services and management parameters; soil and physical desired and services and management parameters; soil and physical desired and services and management parameters; soil and physical desired and services are services and services and services are services. crop and management parameters; soil and physi-cal parameters for soil detachment and transport; pesticide property data such as solubility, expected half-life in soil and/or on foliage, and adsorptivity; and soil physical data by horizon to route water and chemicals. Output data includes, but is not imited to, water, sediment, and pesticide masses in runoff, volumes of water percolated through the root zone, masses of pesticide percolated, and irri-gation volumes required. Daily or storm outputs also provide data on distribution of pesticide within the root zone. (See also W91-09570) (Author's abstract) W91-09589

COMPARING RISKS FROM ROOTWORM INSECTICIDES IN GROUND WATER, SURFACE WATER AND AIR.

North Carolina State Univ. at Raleigh. Dept. of Agricultural and Resource Economics. D. Hoag, and A. Manale.

D. Hoag, and A. Manate. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 293-302. 1 fig, 3 tab, 13 ref.

Descriptors: \*Agricultural chemicals, \*Computer models, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*Water pollution sources, Computer programs, Decision making, Fate of pollutants, Groundwater pollution, Hydrologic models, Insecticides, Maize, Mass transport, Risk assessment, Surface water, Technology transfer.

Efforts to curb environmental degradation and human health risks from agricultural production are increasing. As awareness mounts, decision makers must act. However, information about how solutions to one environmental problem affects other environmental problems is incomplete; this can have the consequence of unexpected and unde-sirable tradeoffs. The risk tradeoffs of seven sirable tradeofts. The risk tradeofts of seven common corn rootworm insecticides used in Iowa were compared across three environments, groundwater, surface water and air. The ranking of the pesticides was altered by the environment being considered. Mocap was hazardous in all environments, and two caused relatively little danger in any of the environments. A value system was used to evaluate the combined effect of pesticide use across the three environments. Under all weighing schemes examined, three pesticides (Mocap, Furadan, and Counter) contributed > 80% of total risk. This project demonstrated how models can be used to provide clear and under-standable information to decision makers. (See also W91-09570) (Author's abstract)

VOLATILIZATION.

Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry. For primary bibliographic entry see Field 7C. W91-09612

GROUND WATER ISSUES AND SOLUTIONS IN THE POTOMAC RIVER BASIN/CHESA-PEAKE BAY REGION. For primary bibliographic entry see Field 2F. W91-09628

GROUNDWATER IN THE NATION'S CAPITAL: BEYOND POTABILITY.

District of Columbia Univ., Washington. Dept. of Environmental Science.

For primary bibliographic entry see Field 2F.

GROUNDWATER NON-POINT SOURCES OF NUTRIENTS TO THE SOUTHERN CHESA-PEAKE BAY.

Virginia Inst. of Marine Science, Gloucester Point. W. G. MacIntyre, G. H. Johnson, W. G. Reay, and G. M. Simmons.

In: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 83-104. 8 fig. 1 tab, 7 ref.

Descriptors: \*Chesapeake Bay, \*Groundwater, \*Nonpoint pollution sources, \*Nutrient transport, \*Nutrients, \*Seepage, Agricultural runoff, Coastal aquifers, Groundwater movement, Nitrates, Nitrogen, Septic wastewater.

The volume of dissolved nutrients entering the Chesapeake Bay and its coastal plain tributaries from shallow unconfined aquifers is unknown and not incorporated in present Bay mathematical models. Measurements on dissolved inorganic nimodels. Measurements on dissolved inorganic ni-trogen in groundwater flowing directly into the lower Chesapeake Bay region have been initiated and groundwater appears to contribute a major amount of nutrient given the present-day land-use practices. Three sites selected for this study are representative of coastal plain stratigraphy and physiography. The Hula Farm site on the James River (agricultural), the Ringfield site in the Colo-nial National Historical Park (forested) and VIMS site at Glucester Pairt (urban sentic) were studsite at Gloucester Point (urban septic) were stud-ied. At each site wells were drilled, sediments were described, and piezometers installed onshore adja-cent to the river for water table elevation monitoring. Representative concentrations of dissolved innic nitrogen are 720, 270, and <25 micro M/L organic introgen are 720, 70, and 25 micro M/L
for the agricultural, urban septic, and forested sites,
respectively. Elevated nitrate concentrations
within the agricultural and urban septic sites indicate a potential significant nutrient source to
Chesapeake Bay. The direct measurement of
groundwater flow to adjacent surface waters was
determined using separage meters. Groundwater determined using seepage meters. Groundwater discharge rates varied from 0.1 to 6.3 liters per square meter per hour. Results of this work will provide baseline nutrient data and seepage measurements which can be used for initial estimates of the importance of groundwater sources of nutri-ents to the Chesapeake Bay and its tributaries below the fall zone. (See also W91-09628) (Author's abstract) W91-09634

NITROGEN TRANSPORT IN GROUND WATER IN TWO GEOLOGIC SETTINGS, PATUXENT RIVER BASIN, MARYLAND. Geological Survey, Towson, MD. Water Re-

sources Div. For primary bibliographic entry see Field 2F. W91-09635

CHARACTERIZATION OF POLLUTION PO-TENTIAL USING HYDROGEOLOGIC SET-TINGS FOR THE FRACTURED ROCKS NEAR THE POTOMAC RIVER, MONTGOMERY COUNTY, MARYLAND.

Geomatrix, Inc., Riverdale, MD.
K. Atobrah, D. A. Jackson, and J. Keiller.
IN: Ground Water Issues and Solutions in the
Potomac River Basin/Chesapeake Bay Region.
National Water Well Association, Dublin, Ohio.
1989. p 125-144. 5 fig, 4 tab. 14 ref.

Descriptors: \*Aquifer characteristics, \*Geohydrology, \*Groundwater, \*Groundwater pollution, \*Potomac River, \*Risk assessment, DRASTIC model, Geologic fractures, Land use, Maryland, Sensitivity analysis, Water pollution sources.

The potential for contamination has been charac-Ine potential for contamination has been characterized in a three year study of the fractured rock aquifers near the Potomac River in the western part of Montgomery County, Maryland. A hierarchy of hydrogeologic sensitivity factors has been employed to demonstrate the relative vulnerability

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of different sites within the area to groundwater pollution. Factors included depth to bedrock, depth to groundwater, structure of the rock formation, topography, recharge, proximity to major surface water bodies, man-made features, and hydraulic parameters for the porous fractured media. Field data for in-situ percolation tests, aquifer pumping tests, stream flow measurements, and cimatic information for the general area were analyzed to determine the groundwater flow pattern within the fractured rocks. The analytical output was compared to evaluation exercises conducted by using other standardized systems for the determination of groundwater pollution potential such as the DRASTIC Index methodology. Results indicate that the fractured aquifer may be vulnerable to pollution in the Potomac River, although the potential for such occurrence at the study area was low. However, the aquifer should be carefully monitored during any future land use activities developed in the general area. (See also W91-09628) (Author's abstract)

EFFECT OF AGRICULTURAL CHEMICALS ON GROUNDWATER QUALITY, NORTHERN SHENANDOAH VALLEY, VIRGINIA.

Virginia Univ., Charlottesville. H. G. Goodell, and R. LoCastro.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 145-167. 11 fig, 4 tab, 11 ref.

Descriptors: \*Agricultural chemicals, \*Groundwater, \*Groundwater pollution, \*Nitrates, \*Nonpoint pollution sources, \*Shenandoah Valley, Animal wastes, Calcite, Domestic water, Herbicides, Pesticides, Virginia.

The effects of agriculture on the near surface water table aquifers in the northern Shenandoah Valley of Virginia was assessed using the results of groundwater samples collected from 229 sites in 1986 and 1987. Most of the samples were collected from existing domestic wells drilled in one of several shallow aquifers. The majority of the samples were collected from wells drilled in the Cambro-Ordovician carbonate aquifer and the valley shale aquifer, with additional samples collected from a clastic aquifer and a metamorphic aquifer. Samples were analyzed for pH, conductivity, bacteria, pesticides, hardness, and inorganic cations and anions. A charge balance was calculated for each sample. Saturation indices for calcite and dolomite were calculated for the samples collected from the carbonate and shale aquifers. The data were statistically analyzed and plotted with graphs and Stiff diagrams. Samples from the carbonate aquifers have substantially higher nitrate values than samples from the other aquifers. Very high point source values appear to be related to animal concentrations with high manure production. Pesticide concentrations in Valley groundwater appear to be controlled by surface land use, with the highest values associated with orchards. Some of the highest herbicide concentrations are associated with non-agricultural land use. It is not likely groundwater quality will improve, particularly in the carbonate areas, until land surface conditions are changed. (See also W91-09628) (Tappert-PTT)

HYDROCHEMICAL PROCESSES AFFECTING CONTAMINANTS NEAR THE GROUND WATER/SURFACE-WATER INTERFACE, AB-ERDEEN PROVING GROUND, MARYLAND. Geological Survey, Towson, MD. D. A. Vroblesky.

D. A. Vroblesky.

In: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 169-186. 8 fig. 19 ref.

Descriptors: \*Estuaries, \*Estuarine sediments, \*Fate of pollutants, \*Groundwater, \*Groundwater pollution, \*Path of pollutants, \*Surface-groundwater relations, \*Water chemistry, Ice cover, Maryland, Methane, Organic compounds, Oxidation-reduction potential, Salinity. Groundwater contaminants discharging into estuarine surface water bodies may undergo chemical changes near the groundwater/surface-water interface that alter the speciation, mobility, and toxicity of individual contaminants. In some areas, localized infiltration of surface water into groundwater produces a subsurface mixing zone that may further complicate the transport process. The dominant hydrochemical processes affecting inorganic constituents in the vicinity of the interface are redox reactions, although salinity changes also may play a role. The potential for biodegradation of organic contaminants may increase or decrease, depending on organic speciation. Once in the surface water, the potential for volatilization of certain organic compounds can limit their transport as dissolved phases. However, during periods of winter ice cover, volatilization is limited, as shown by accumulations of volatile organic compounds below the ice at the site. Moreover, during summer months when decomposition of the organic-rich bottom sediment in the creeks produces interstitial methane bubbles, partitioning of volatile organic compounds into the bubbles may provide a transport mechanism through the sediment and water column. Analysis of the bubbles for contaminant content has been successfully used to locate a previously undetected groundwater contaminant discharge zone. (See also W91-09628) (Author's abstract)

COVER CROPS: A PARAGON FOR NITRO-GEN MANAGEMENT.

Maryland Univ., Queenstown. Wye Research and Education Center. For primary bibliographic entry see Field 5G. W91-09643

EFFECT OF STORM-WATER IMPOUND-MENTS ON MAJOR-ION RATIOS IN GROUND WATER.

F. D. Wilde.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 287-311. 16 fig, 2 tab, 17 ref.

Descriptors: \*Detention reservoirs, \*Storm runoff, \*Storm water, \*Storm water management, \*Water pollution sources, Chlorides, Groundwater chemistry, Infiltration, Inorganic compounds, Maryland, Vadose zone, Water chemistry.

Concern over nonpoint source pollution of the Chesapeake Bay has resulted in the enactment of legislation in Maryland requiring the discharge of urban storm runoff to impoundment structures, where storm water is allowed to percolate through the unsaturated zone. However, the effect of storm water on groundwater quality has not been well studied in Maryland. A 5-year project to monitor storm and groundwater quality is underway at three stormwater management facilities. Two types of impoundment facilities are being monitored: infiltration ponds and porous asphalt pavement. A sampling program has been implemented to (1) determine the chemical composition of storm water and background groundwater, and (2) monitor changes in the chemical composition of storm water. Analysis of data collected over 2 years indicates a significant change in the major ion chemistry of groundwater receiving infiltrate from the stormwater impoundments. Calcium:magnesium and magnesiumsodium ratios and ratios of chloride to other anions reflect mixing of background groundwater with the stormwater infiltrate. However, mechanisms other than simple mixing are involved. The pH of impounded stormwater ranges from 7.0 to greater than 9.0, but groundwater pH is less than 6.0 and tends to decrease downgradient. Moreover, although elevated chloride concentration in stormwater occur during the winter season only, chloride levels in underlying groundwater are highest during the summer and fall and remain above background throughout the year. (See also W91-09628) (Author's abstract)

MUNICIPAL AND INDUSTRIAL LANDFILL LEACHATE MOBILITY THROUGH THE WATER TABLE AQUIFER SYSTEM OF THE NORTHERN VIRGINIA COASTAL PLAIN, RESOURCE INTERNATIONAL LTd. ASHJANG VA.

D. W. Hintz.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989, p 313-329, 5 fig, 7 ref.

Descriptors: \*Coastal plains, \*Groundwater pollution, \*Landfills, \*Leachates, \*Path of pollutants, \*Water pollution sources, \*Water table aquifers, Chesapeake Bay, Coastal aquifers, Shallow aquifers, Solid waste disposal, Virginia, Water quality.

The water table aquifer system of the Coastal Plain Province of Virginia presents numerous problems for solid waste disposal. Maximum separation of groundwater from solid waste is desirable to protect water quality; however, in terms of actual landfill design the minimum allowable distance of separation as set by state regulations is the norm. Many illegal and legal landfills permitted prior to Federal regulation may be serious threats to water quality in the water table aquifer system. The Chesapeake and Columbia Group of sediments that dominate the near surface of this region are highly permeable, which allows for rapid diffusion of contaminants such as leachate into the aquifer system. With this diffusion comes a high degree of attenuation. Field experience and modeling has shown that the degree of attenuation is also a function of leachate composition. Given sufficient retention time and lateral ly have little detriment to the overall water quality of the Chesapeake Bay and its tributaries. To reduce potential impacts, landfills should be required to operate on clay laden sediments and groundwaters to allow for adequate attenuation of groundwater to call and the sediments and groundwater contaminants. (See also W91-09628) (Author's abstract)

PREDICTING IMPACTS OF SUBDIVISION DEVELOPMENT IN LOUDOUN COUNTY, VIRGINIA.

GeoTrans, Inc., Herndon, VA.

R. M. Cohen, N. D. Durant, J. R. Mittauer, and L. L. August.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 331-353. 10 fig, 3 tab, 14 ref.

Descriptors: \*Groundwater pollution, \*Urban hydrology, \*Virginia, \*Water demand, \*Water requirements, \*Water resources development, \*Water supply, Groundwater management Septic drain fields, Water resources data, Water scarcity, Water shortage, Wells.

The rate of rural subdivision development in Loudoun County, Virginia has increased in the past few years. Most new developments include minimum three acre lots with individual wells and septic drainfield systems. Uncertainty regarding the availability of adequate groundwater supplies at proposed subdivision sites prompted the County government to require hydrogeologic studies prior to site development beginning in 1987. Study requirements include drilling test wells, conducting aquifer tests, analyzing groundwater quality, determining the adequacy of the groundwater supply, and predicting drawdowns and water quality impacts to result from subdivision development. Hydrogeologic investigations at subdivision sites throughout much of the Triassic and Blue Ridge Provinces within Loudoun County in 1988 have greatly improved knowledge of local groundwater resources. Drilling and aquifer test results indicate that adequate groundwater supplies are generally available to support minimum three acre lot subdivision development. Prediction of water quality impacts to result from onsite sewage disposal sys-

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Sources Of Pollution—Group 5B

tems is subject to considerable uncertainty. Implementation of an integrated groundwater monitor-ing program would enhance the County's ability to detect longterm drawdown and water quality trends. (See also W91-09628) (Author's abstract) W91-09646

LAWN AND GARDEN CHEMICALS AND THE POTENTIAL FOR GROUNDWATER CON-TAMINATION.

New Hampshire Univ., Durham. J. M. Halstead, W. R. Kerns, and P. D. Reif. J. M. Haistead, W. R. Kerns, and P. D. Keil. IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 355-369. 7 tab, 18 ref.

Descriptors: \*Groundwater pollution, \*Herbicides, \*Pesticides, \*Urban runoff, \*Water pollution sources, Agricultural chemicals, Carbamate pesti-cides, Fertilizers, Glyphosate, Pesticide toxicity,

Public concern over the impacts of pesticides and fertilizers on groundwater quality is increasing. A telephone survey of Virginia homeowners was conducted in 1988 to collect information concerning domestic use of chemicals on lawns and gardens. From an initial sample group of 180 homedens. From an initial sample group of 180 home-owners, 149 usable surveys were collected. The average lawn size of homeowner respondents was approximately 0.66 acres. One hundred nineteen respondents used chemicals on their lawns. Almost sixty percent of the homeowners relied upon mu-nicipal supplies for drinking water. The most popu-lar insecticide was Sevin, a carbamate, and the most popular herbicide was glyphosate, marketed under several names. Most of the chemicals used under several names. Most of the chemicals used are classified as moderate to low toxicity. Many respondents indicated they use the products as needed, indicating that significant personal judgement is being used. The single most important source of information for homeowners was the extension service, followed by label instructions. On average, respondents were moderately con-cerned about the impact of home and garden care chemicals on the environment. One of the most disturbing aspects of the survey was that many respondents did not feel that label instructions respondents and not reer that laber instructions were easily comprehensible. (See also W91-09628) (Tappert-PTT) W91-09647

IMPACTS OF HIGHWAY DEICING PROGRAMS ON GROUNDWATER AND SURFACE WATER QUALITY IN MARYLAND.
GeoTrans, Inc., Herndon, VA.
L. L. August, and T. A. Graupensperger.
IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 371-395. 8 fig, 4 tab, 8 ref.

Descriptors: \*Deicers, \*Groundwater, \*Highway effects, \*Maryland, \*Nonpoint pollution sources, \*Salts, Chlorides, Sodium, Streamflow, Traveltime, Water pollution sources, Water quality stand-

The impacts of deicing practices on surface water and groundwater are assessed in two studies conducted for the Maryland State Highway Administration. The groundwater study focused on three tration. The groundwater study focused on three sites in Garrett County, Maryland. The study results indicate that past open-air storage of deicing salts at the Keysers Ridge maintenance facility and the application of deicing salts in the Keysers Ridge, Grantsville, and Finzel study areas are responsible for the increased levels of sodium and chloride observed in the groundwater and soils at these sites. In localized parts of each study area, the levels of chemicals in groundwater exceed Maryland drinking water standards for chloride and recommended standards for sodium. Preliminary groundwater travel times of less than 10 years have been calculated for each study area. The travel times of solutes are expected to be longer due to the lag time created by retardation processes. In general, the occurrence of groundwater contamination in the study areas is a function of the following factors: (1) aquifer hydraulic properties,

(2) proximity to the source of contamination, (3) construction characteristics of wells and physical construction characteristics of wells and physical characteristics of springs, (4) local surface topogra-phy and roadway drainage, and (5) type of flow regime (porous flow or fracture flow). The second study on Chesapeake Bay tributaries was conductstudy on Chesapeake Bay tributaries was conducted to assess the effects of decining practices on
surface waters drained by the Chesapeake Bay.
The data suggest that the relatively larger loads of
salt entering the streams during the deicing season
have little or no impact on the water quality with
respect to existing water quality standards in
Maryland. The greatest impacts of deicing chemicals occur in small drainage basins which receive
large salt loads. (See also W91-09628) (Author's
abstract) abstract) W91-09648

FLOW PATH OF PESTICIDES IN THE DELAWARE AND MARYLAND PORTION OF THE CHESAPEAKE BAY REGION.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
T. S. Steenhuis, J. Hagerman, N. B. Pickering, and

W. F. Ritter.
IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 397-419. 9 fig, 2 tab, 34 fig. United States Environmental Agency Grant No. R81-2919-01-0.

Descriptors: \*Chesapeake Bay, \*Groundwater pol-lution, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*Solute transport, Convection, Dispersion, Dye releases, Flow pattern, MOUSE model, Tracers, Vadose

The groundwater underlying agricultural soils in Delaware and Maryland is susceptible to contamination from agricultural chemicals because the nation from agricultural chemicals because the soils are generally quite sandy. Pesticides are used extensively, and groundwater contamination by these pesticides has been noted in several cases. Unlike the predictions of traditional simulation models based on the convective-dispersive solute transport equations, these pesticides move from the surface to the groundwater within a period sometimes as short as two weeks after the application. Most model simulations (such as Model of Undervative Models) predict transport expend Solute Evaluation MODISD predict transport ground Solute Evaluation, MOUSE) predict travel times of a half year or longer. To investigate pesticide flow paths in the vadose zone, a bromide tracer and an organic dye which has many of the same transport characteristics as pesticides were applied at a slow rate on the land surface and then collected at a depth of 1.2 m using 4 pan lysimeters, each divided into twenty-five 6 x 6 cm meters, each divided into twenty-five b x b cm compartments. The bromide and dye breakthrough curves for each of the compartments were analyzed and inferences were made of the preferential flow through fingers in an unstable flow field. For accurate prediction of fate of pesticides in the Chesapeake Bay Region, information on the distribution of preferential flow paths is essential. (See also W91-096428) (Author's abstract)

IMPACT OF AGRICULTURAL ACTIVITIES ON GROUNDWATER QUALITY IN VIRGINIA. Virginia Polytechnic Inst. and State Univ., Blacksburg. S. Mostaghimi, P. W. McClellan, U. S. Tim, T. M.

S. Mostagnimi, F. W. McCleilan, U. S. 11m, 1. M. Dillaha, and R. R. Byler. IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 421-435. 4 fig, 7 tab, 11 ref.

Descriptors: \*Baseline studies, \*Groundwater, \*Groundwater pollution, \*Nonpoint pollution sources, \*Nutrients, \*Pesticides, \*Water pollution sources, Agricultural practices, runoff, Fate of pollutants, Virginia. Agricultural

In 1983, the EPA Chesapeake Bay study concluded that nonpoint source pollution from agricultural areas is responsible for a significant portion of the water quality degradation in the Bay. Virginia has implemented a cost-sharing program to encourage

the adoption of conservation tillage and other best management practices that reduce pollutant losses from agricultural areas. In 1985, a comprehensive watershed/water quality monitoring program was initiated in the Nomini Creek watershed as part of initiated in the nomini Cree watersned as part of the Chesapeake Bay program, to evaluate the effectiveness of best management practices on surface and groundwater quality. Baseline data was collected prior to the implementation of Best Management Practices techniques. Several runoff and precipitation measurement sites were established, surface water samples were collected, and eight monitoring wells were installed to provide ground-water samples. Wells and monitoring stations were located to evaluate the effects of different land located to evaluate the effects of different land management approaches. Wells were sampled monthly, and land use evaluations were made quarterly, with selected fields monitored monthly. Water and soil samples were analyzed for nutrients, herbicides, insecticides, total suspended solids, and chemical oxygen demand. Data collected from the water shed indicate that agricultural activities are contributing to pesticides in the water some of which are present at levels above water, some of which are present at levels above health advisory limits. (See also W91-09628) (Tappert-PTT) W91-09650

TWO-DIMENSIONAL NONPOINT SOURCE POLLUTION MODEL FOR SIMULATING PESTICIDE MOVEMENT TO THE WATER

Greenhorne and O'Mara, Inc., Greenbelt, MD. D. A. Lehman, A. Shiromohammadi, T. J. Gish, and W. L. Magette.

IN: Ground Water Issues and Solutions in the

Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 457-479. 3 fig, 32 ref.

Descriptors: "Groundwater, "Groundwater pollution, "Model studies, "Nonpoint pollution sources, "Path of pollutants, "Pesticides, ANSWERS model, Agricultural practices, CMIS model, CREAMS model, Computer models, GLEAMS model, PRZM model.

Federal, state, and local agencies are becoming increasingly concerned about the effects of nonpoint source pollution on our environment. The Chesapeake Bay is experiencing severe effects from this type of pollution. A system of models have been developed to simulate surface runoff, erosion, surface pollution, transport through the erosion, surface pollution, transport through the root zone, plant uptake, vadose zone water movement and solute transport, and loading of pollutants to groundwater. Some of the models available include CREAMS, GLEAMS, PRZM, ANSWERS, and CMIS. Existing models can be applied to examine best management practices for certain conditions. While each model addresses certain characteristics of the problem, components of several models and modifications have been used in developing a comprehensive watershed model. The model under development will simumodel. The model under development will simulate transport of pesticides through the root zone and vadose zone with a two-dimensional approach, allowing the prediction of pesticide loading to groundwater and surface water. The model will be continuous and will use daily rainfall data. The GLEAMS erosion component and a modified form of the PRZM chemical component will be used. It is hoped that the model can be developed into a powerful tool for examining nonpoint source pollution and identifying comprehensive best management practices. (See also W91-09628) (Tappert-PTT)
W91-09652 W91-09652

DIATOM FRUSTULES AS NATURAL TRACERS TO DETERMINE THE ORIGIN OF SUS-PENDED MATTER IN THE WESER ESTUARY.

Bremen Univ. (Germany, F.R.). For primary bibliographic entry see Field 2L.

DETERMINATION OF THE CONCENTRA-TION OF ALKYLLEAD COMPOUNDS IN FISH AND WATER.

#### Group 5B-Sources Of Pollution

Institute of Aerosol Science, University of Essex, Colchester, CO4 3SQ, U.K.
A. G. Nerves, A. G. Allen, and R. M. Harrison.

A. G. Nerves, A. G. Allen, and R. M. Harrison. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 877-882, 1990. 6 tab, 15 ref.

Descriptors: \*Bioaccumulation, \*Hydrocarbons, \*Lead, \*Path of pollutants, \*Toxicity, \*Toxicology, \*Water pollution sources, Aliphatic hydrocarbons, England, Inorganic compounds, Organic compounds,

Marine toxicity resulting from alkyl-, and inorganic lead compounds is a major environmental concern. The presence of di-, tri-, tetraalkyl and inorganic lead compounds in freshwater and seawater and in fish from the North Sea in the eastern U.K were determined. Detection limits were between 0.03-0.44 ng Pb g-1 and 0.1-1.0 ng Pb l-1 for fish and water, respectively. Of 123 fish analyzed, 15 (12%) were found to contain measurable amounts of alkyllead compounds. Comparisons between concentrations in fish and their water environment indicated preferential fish uptake of alkyllead species relative to inorganic lead. (D'Agostino-PTT) W91-09664

ANAEROBIC BIOCONVERSION OF PHTHAL-IC ACID ESTERS BY NATURAL INOCULA. Georgia Inst. of Tech., Atlanta. School of Biology and Research

Georgia inst. of School, The American Acceptance and Research.
S. E. Painter, and W. J. Jones.
Environmental Technology (Letters) ETLEDB,
Vol. 11, No. 11, p 1015-1026, 1990. 1 fig, 6 tab, 31 ref.

Descriptors: \*Biotransformation, \*Fate of pollutants, \*Microbial degradation, \*Organic pollutants, \*Path of pollutants, \*Priority pollutants, Anaerobic conditions, Sediment contamination

Non-plasticizer phthalic acid esters (PAEs) are used in pesticides, cosmetics, fragrances, insect repellents, and condensers. They are not bound by a resin matrix, as in plastic products, and affect the environment by direct contamination rather than by slow leaching. Several PAEs are also EPA listed as priority environmental pollutants. To assess the ecological fate of these compounds, the anaerobic bioconversion of several prevalent PAEs using inocula from diverse anaerobic natural habitats was investigated. After 4 weeks, di-n-butyl phthalate (DBP) and butyl benzyl phthalate (BBP) levels were reduced by 80 and 50%, respectively, in samples inoculated with diluted anaerobic digester sludge. In samples treated with either anaerobic freshwater or salt marsh sediment, greater than 90% bioconversion of DBP and BBP was not several bis(2-ethylkexyl) phthalate (DEHP) was not degraded by any inocula tested and DEHP persistence was not associated with toxicity to the indigenous microflora. All data indicated that microbial inocula from diverse natural habitats may support the anaerobic bioconversion of environmentally significant PAEs. (D'Agostino-PTT)

INFLUENCE OF ACID MINE WATER IN THE DISTRIBUTION OF HEAVY METAL IN SOILS OF DONAN NATIONAL PARK, APPLICA-TION OF MULTIVARIATE ANALYSIS.

Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Quimica Organica General.

M. J. Gonzalez, M. Fernandez, and L. M. Hernandez.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 11, p 1027-1038, 1990. 4 fig, 4 tab, 17 ref. Supported by CYCIT and CSIC.

Descriptors: \*Acid mine drainage, \*Heavy metals, \*Mine wastes, \*Path of pollutants, \*Sediment contamination, \*Spain, Acidic water, Cadmium, Copper, Guadiamar river, Hydrogen ion concentration, Lead, Mercury, Zinc.

The Guadiamar River is one of the most important water supplies of the Donana National Park in southwest Spain. During 1983-85, mining activities at Aznalcollar, about 40 km away, decreased the

river pH, causing subsequent transport of solubilized heavy metals to the park. Multivariate analysis was used to assess the sudden change in the distribution of metal pollutants in park soils. Under the acidic conditions caused by piritas smelting, Hg, Cd, and Zn have shown a higher migration capacity than Pb, and Cu; and since 1984, the Guadiamar River is carrying considerable quantities of Hg to the park shores. Such factors altering the existing balance between the contaminants' entry into an ecosystem and its natural evolution, may lead to non-recuperable damage. (D'Agostino-PTT)

SOIL MERCURY POLLUTION IN THE AREA SURROUNDING THE STATE OIL REFINERY OF ASPROPIRGOS GREECE.

OF ASTROPHROOS GREECE,
Agricultural Coll. of Athens (Greece). Lab. of
Soils and Agricultural Chemistry.
C. Haidouti.

Catena, Vol. 18, No. 1, p 1-10, February 1991. 2 fig, 4 tab, 26 ref.

Descriptors: \*Greece, \*Mercury, \*Soil contamination, Air pollution effects, Oil refineries, Path of pollutants, Soil samples.

The airborne contamination of soils with mercury (Hg) was evaluated from soil samples near the state oil refinery of Aspropirgos-Attiki, Greece. High levels of mercury enrichment were found in the upper 0-5 cm. The contamination is particularly heavy near the contamination source and falls off with distance. DTPA, 0.5 N NaHCO3, and 1 N HCl were used in order to determine available Hg, weakly organic bound Hg and strongly adsorbed Hg, respectively. The analysis showed that small amounts of mercury existed in an easily soluble state. Mercury occurs in soils mostly in the form of poorly soluble compounds. Particle size separations showed that more than 50% of the total mercury content is confined to separate 0.005-0.001 and <0.001 mm of diameter, and density gradient centrifugation indicated that mercury in soils is generally associated with organomineral fractions <2.8 g/cu cm. (Author's abstract) W91-09600

LONG-TERM EFFECTS OF HIGH APPLICA-TION RATES OF NPK FERTILIZER ON TEN-SILE STRENGTH AND WATER STABILITY OF THE SOIL STRUCTURE.

Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water. For primary bibliographic entry see Field 5C. W91-09700

CONTAMINATION OF SOIL AND GROUND-WATER BY AUTOMATIC TRANSMISSION FLUID: SITE DESCRIPTION AND PROBLEM ASSESSMENT. General Motors Research Labs., Warren, MI. En-

General Motors Research Labs., Warren, Ml. Environmental Science Dept. A. S. Abdul, T. L. Gibson, and S. F. Kia. Journal of Hydrology JHYDA7, Vol. 121, p 133-153, December 1990. 12 fig., 1 tab, 10 ref.

Descriptors: \*Groundwater pollution, \*Industrial wastes, \*Path of pollutants, \*Soil contamination, \*Transmission fluid, Aquifers, Assessments, Cores, Field tests, Monitoring wells, Pollutant identification, Sampling, Waste disposal.

Soil and groundwater beneath a region of a manufacturing plant in Michigan are contaminated with automatic transmission fluid (ATF). The extent of contamination was assessed by maximizing the use of real-time data from soil-core sampling and monitoring wells. The number, location, and depth of cores and of monitoring wells were determined during the investigation based on: (1) inspection and analysis of soil-core samples immediately after each core was taken; (2) physical and chemical measurements of core samples at the end of each day; and (3) measurements in monitoring wells at several stages during the investigation. This approach differs significantly from the conventional approach using randomly placing wells throughout the hydrogeologic system. Soil cores were taken

and monitoring wells installed at 53 locations. The perched aquifer extends to about 13 ft and is comprised mainly of sandy materials, which have spatial heterogeneity in size distribution and hydraulic properties. The region of ATF contamination is comprised of three distinct and contiguous layers. The center layer is about 2.6 ft. deep at its thickest point and extends to about 250 ft. at its widest point. The soil in this zone is about 85% saturated with 133,000 plus or minus 21,000 gal. of ATF, which has depressed the water table into the aquifer. The top layer is about 14 in. thick and contains about 50,640 gal. of ATF held by capillary forces. The amount of ATF in this zone decreases with height above the center layer from about 85% saturation to residual saturation (20%). The amount of ATF in the deepest layer is near the residual saturation. This investigative approach did not spread the ATF to clean regions of the aquifer as could occur with conventional approaches, and it provided the data needed to assess the problem and to design a cleanup plan. (Author's abstract) W91.09716

EFFECT OF TRANSVERSE DISPERSION ON SOLUTE TRANSPORT IN SOILS.

Auburn Univ., AL. Dept. of Agronomy and Soils. For primary bibliographic entry see Field 2G. W91-09754

TRACE METAL LEVELS IN SHARKS FROM BRITISH AND ATLANTIC WATERS,

Salford Univ. (England). Dept. of Biological Sciences.
P. Vas

Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 67-72, February 1991. 7 tab, 32 ref.

Descriptors: \*Atlantic Ocean, \*Bioaccumulation, \*Path of pollutants, \*Shark, \*Trace metals, Atomic absorption spectrophotometry, Cadmium, Copper, England, Food habits, Iron, Lead, Manganese, Monitoring, Nickel, Tissue analysis, Zinc.

Because the commercial importance of sharks is increasing, it is important to document baseline pollutant concentrations in any species subject to exploitation. Tissue samples from 46 sharks representing ten species and four locations were analyzed for 7 trace metals (Cu, Mn, Fe, Cd, Ni, Pb, Zn) using atomic absorption spectrophotometry. Observed concentration ranges were (micrograms/g): Cu 0.02-68; Mn 0.02-9; Fe 0.2-> 200; Cd < 0.02-68; Mn 0.02-9; Fe 0.2-> 200; Cd < 0.02-66; Ni 0.02-11.5; Pb 0.1-13; and Zn < 0.1-90. The highest metal concentrations were observed in 'inshore demersal species,' while the lowest were in 'offshore pelagic species.' Cu was of greater importance to demersal sharks, while a similar relationship was observed for Ni in pelagic sharks. These differences were believed to be a function of diet. Although mean concentrations were generally low, some individual sharks contained metal concentrations in excess of those considered safe for human consumption. This is most probably a function of the longevity of each species. Future monitoring should address the problem of ontogenetic changes in tissue metal levels. Similarly, the high concentrations detected in some individuals dictate the need for careful monitoring of exploited species. (Doria-PTT)

REGRESSION MODELS FOR ASSESSING TRENDS IN CADMIUM AND PCBS IN COD LIVERS FROM THE OSLOFJORD.

Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research.

M. D. Nicholson, N. W. Green, and S. J. Wilson. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 77-81, February 1991. 2 fig, 2 tab, 17 ref, append.

Descriptors: \*Bioindicators, \*Cadmium, \*Cod, \*Liver, \*Oslofjord, \*Polychlorinated biphenyls, \*Regression analysis, \*Water pollution sources, \*Water quality trends, Fjords, Industrial wastewater, Model studies, Municipal wastewater, Norway, Statistical analysis, Tissue analysis.

# WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

Sources Of Pollution-Group 5B

Trend studies of contaminants measured in fish liver have expressed concentrations on different bases (e.g., dry liver weights, dry weights, or fat weights) and regressed them against different variables. This makes the results of studies difficult to compare. A simple model is presented, showing that various combinations of bases and variables. are equivalent. The model was used to assess trends in cadmium and PCBs in cod livers from the Oslofjord, Norway, for 1981-1986. The changes in concentration from year to year were not the same for cadmium and PCBs. Cadmium levels were for cadmium and PCBs. Cadmium levels were similar throughout the Oslofjord, and fluctuated from year to year with no discernible trend. PCBs showed a large difference between the inner-Oslofjord and the combined mid and outer-Oslofjord. The contaminant load is largely from industry and metropolitan sewage in the Oslo city region; the higher concentrations presumably reflect the proximity of the source. Concentrations show a dip in the years between 1981 and 1985, and a sharp decrease in 1986. The fitted equations have implications for data collection. For both cadmium and cations for data collection. For both cadmium and PCBs, if concentrations are expressed on a liver weight or fat weight basis, both liver weight and fat, either as weight or as percentage of liver weight, must also be reported. If concentration is expressed on a dry weight basis, dry weight must also be reported, but only to re-express concentration on a liver weight or fat weight basis. (Doria-PTT) cations for data collection. For both cadmium and W91-09761

GAS CHROMATOGRAPHIC SEPARATION OF THE ENANTIOMERS OF MARINE ORGANIC POLLUTANTS: DISTRIBUTION OF ALPHAHCH ENANTIOMERS IN THE NORTH SEA. Hamburg Univ. (Germany, F.R.). Inst. fuer Organische Chemie und Biochemie.
J. Faller, H. Huhnerfuss, W. A. Konig, and P.

Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 82-86, February 1991. 4 fig. 1 tab, 9 ref. Ministry of Science and Technology (West Germany) Projects MFU 0545 and MFU 0620.

Descriptors: \*Biodegradation, \*Chlorinated hydrocarbons, \*Fate of pollutants, \*Gas chromatography, \*Marine pollution, \*North Sea, \*Organic pollutants, Atlantic Ocean, Coastal environment, Degradation, Elbe River, Lindane, Norway, Pollutant identification, Reagents.

The enantiomeric ratio of alpha-hexachlorocyclo-The enantiomeric ratio of alpha-hexachlorocyclo-hexane (alpha-HCH) in water samples representing different parts of the North Sea was determined by capillary gas chromatography using heptakis (3-0-butyyl-2-6-di-O-pentyl)-beta-cyclodextrin as chiral stationary phase. The correlation between the en-antiomeric ratios and the concentrations of alpha-HCH and gamma-HCH, respectively, allowed a tentative characterization of different microbiol-orical descriptions and the local base of the con-trol descriptions. gical degradation pathways in the North Sea. In the plume of the river Elbe, the Skagerrak, and the Norwegian coastal current, higher gamma-HCH concentrations correlated with high alpha-HCH and low gamma-HCH concentrations, implying an enantioselective degradation of alpha-HCH. Enantiomeric ratios of (+)-alpha-HCH/(-)-alpha-HCH=1 in the North Sea areas of the Atlantic HCH=1 in the North Sea areas of the Atlantic inflow suggest the importance of nonenzymatic degradation processes in ocean areas far away from sources of pollutants. In order to verify these hypotheses, model experiments are being performed to determine which degradation pathway gives rise to the observed excess of alpha-HCH, be it an excess of (+)-alpha-HCH as observed off the English coast or be it an excess of (-)-alpha-HCH as encountered in the plume of the River Elbe, the Skagerrak, an the Norwegian coastal current. (Doria-PTT) w91-09762 W91-09762

RELATIONSHIPS BETWEEN HEAVY METAL CONTENT AND BODY WEIGHT OF FISH FROM THE KELANG ESTUARY, MALAYSIA. Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science.

A. T. Law, and A. Singh.

Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 86-89, February 1991. 4 fig, 1 tab, 18 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Estuarine environment, \*Fish, \*Heavy metals, \*Kelang Estuary, \*Path of pollutants, Copper, Correlation analysis, Crustaceans, Food habits, Industrial wastes, Lead, Malaysia, Mercury, Mollusks, Muscle, Statistical analysis, Tissue analysis,

The correlations between mercury, lead, copper, and zinc content and body weight of some estuarine fishes caught in the Kelang estuary (Malaysia) over a period of two years (1980-1982) are reported. For Plotosus anguillaris, the correlation coeffied. For Plotosus anguillaris, the correlation coeffi-cients between lead, copper, and zinc versus body weight were 0.88, 0.90, and 0.85, respectively, and the values were significantly correlated. For mer-cury, the coefficient was low (0.40) but it was also significantly correlated. Poor correlation coeffi-cients were found for Dasyatis zugeri. However, statistical analyses showed that lead and zinc con-tents were significantly correlated but mercury and copper were not. Heavy metal content in the muscle tissue of fish is probably related to the feeding habit and distribution pattern of the fish. Arius thalassinus and P. anguillaris are considered Artist maissinus and F. anguinaris are considered estuarine fishes feeding mainly on small crustaceans, mollusks, and fish. Thus, the heavy metal content of their muscle tissue probably reflects the heavy metal concentrations in the estuary. The close relationships between the heavy metal considered the statement of the stateme close relationships between the heavy metal con-tent and body weight of A. thalassimus and P. anguillaris and the poor relationships in D. zugeri seem to support this hypothesis. The mercury, lead, copper, and zinc contents in fish collected from the Kelang estuary were significantly higher than those from the Setiu estuary, which is free of than those from the Setul estuary, which is free of industrial pollution. This study indicates that A. thalassinus and P. anguillaris could be used as indicator organisms for the assessment of the relative degree of heavy metal pollution in the estuary.

(Doria-PTT) W91-09763

#### SIMPLE AND MULTIPLE TRACE METAL CORRELATIONS FOR SOME COMMERCIAL FISH FROM THE ARABIAN SEA.

Pertanian Malaysia Univ., Serdang. Faculty of Fisheries and Marine Science.

M. Ashraf, and M. Jaffar. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 89-91, February 1991. 1 fig, 3 tab, 13 ref.

Descriptors: \*Arabian Sea, \*Bioaccumulation, \*Correlation analysis, \*Marine fisheries, \*Trace metals, Bream, Catfish, Copper, Fish, Fish physiology, Food habits, Iron, Lead, Metabolism, Regression analysis, Shad, Zinc.

Simple and intermetallic correlations were evolved between concentrations of Fe, Zn, Cu, and Pb in six species of marine fish from the Arabian Sea. The species included in the study are toli shad (Tenualosa toli), giant catfish (Arius thalassinus), talang queenfish (Scomberoides commersoniantalang queenfish (Scomberoides commersonian-aus), threadfin bream (Nemipterus japonicus), silver grunt (Pomadasys argyreus), and goldlined sea bream (Rhabdosargus sarba). Levels of trace metals were found to lie within the safe range. The mean iron concentration in various species was comparable to that previously reported at 3.3 mi-crograms/g wet weight. The average zinc level was comparable with the reported range of 3.3-4.1 micrograms/g. Average lead levels ranged from 0.03 to 0.06 micrograms/g. Average copper con-centrations ranged between 0.11 and 0.31 micro-grams/g. The study revealed considerable variacentrations ranged between 0.11 and 0.31 micro-grams/g. The study revealed considerable varia-tion in trace metal levels among various species. Regression analysis showed that no two fish spe-cies were identical in terms of trace metal interrela-tion, which critically depends, besides metabolic behavior, on the dietary habits and geographical origin of the individual species. This suggests that the observed distribution and correlations of trace metal concentrations might be attributed to the biology of the species. However, additional data are required to check whether such correlations are useful for undertaking the metal enrichment process in fish species. (Doria-PTT) process in fi W91-09764

FACTORS INFLUENCING MERCURY CON-CENTRATION IN WALLEYES IN NORTHERN WISCONSIN LAKES.

National Fisheries Contaminant Research Center, La Crosse, WI. Field Research Station.

J. G. Wiener, R. E. Martini, T. B. Sheffy, and G.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 5, p 862-870, September 1990. 1 fig, 3 tab, 51 ref. EPA Cooperative Agree-ment CR809484.

Descriptors: \*Acid rain effects, \*Bioaccumulation, \*Lake acidification, \*Lakes, \*Mercury, \*Pikeperch, \*Water chemistry, \*Wisconsin, Acid neutralizing capacity, Alkalinity, Bioavailability, Fate of pollutants, Heavy metals, Hydrogen ion concentration, Methylmercury, Muscle, Regression analysis, Tissue analysis, Water pollution effects.

Relations were investigated between mercury con-centrations in walleyes (Stizostedion vitreum) and the characteristics of clear-water Wisconsin lakes, which spanned a broad range of pH values (5.0-8.1) and acid-neutralizing capacities (-9 to 1,017 microeq/L). Total concentrations of mercury in axial muscle tissue of walleyes (total length 25-56 cm) varied from 0.12 to 1.74 micrograms/g wet cm) varied from 0.12 to 1.74 micrograms/g wet weight. Concentrations were greatest in fish from the 8 lakes with pH less than 7.0; concentrations in these fish equaled or exceeded 0.5 micrograms/g in 88% of the samples analyzed and 1.0 micrograms/g in 44%. In the five lakes with pH of 7.0 and above, concentrations exceeded 0.5 micrograms/g in only 1 of 21 walleyes. Multiple regression revealed that lake pH and total length of fish accounted for 69% of the variation in mercury concentration in walleyes. Regression models, with centration in walleyes. Regression models with total length and either waterborne calcium or acidneutralizing capacity as independent variables ac-counted for 67% of the variation in concentration. The observed differences in fish mercury concentration between the low-pH and high-pH lakes could not be logically attributed to differences in could not be logically attributed to differences in growth rate or diet among the walleye populations. Moreover, it is improbable that mercury influxes to the low-pH lakes were greater than those to the high-pH lakes. The observed pH-related trend in mercury concentration in walleyes the state of the physical transfer of the physical transfer of the lakes in the lake was attributed to variation among the lakes in within-lake processes that affected the production and bioavailability of methylmercury. (Author's W91-09766

# WATER-QUALITY CHARACTERISTICS OF INFLOW TO AND OUTFLOW FROM B. EVER-ETT JORDAN LAKE, NORTH CAROLINA,

Geological Survey, Raleigh, NC. Water Resources

For primary bibliographic entry see Field 2E. W91-09819

# WATER-QUALITY CHARACTERISTICS OF INFLOW TO AND OUTFLOW FROM FALLS LAKE, NORTH CAROLINA, 1982-87.

Geological Survey, Raleigh, NC. Water Resources

For primary bibliographic entry see Field 2E. W91-09820

# GROUNDWATER QUALITY AND PRELIMINARY ASSESSMENT OF THE POTENTIAL FOR CONTAMINATION BENEATH AGRICUL-TURAL LANDS IN CENTRAL LONOKE COUNTY, ARKANSAS,

Geological Survey, Little Rock, AR. Water Resources Div.
V. A. Leidy, and E. E. Morris.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4099, November 1990. 31p, 3 fig, 5 tab, 21 ref.

Descriptors: \*Agriculture, \*Arkansas, \*Groundwater, \*Groundwater pollution, \*Nonpoint pollution sources, \*Pesticides, \*Water pollution sources,

### Group 5B-Sources Of Pollution

\*Water quality, Alluvial aquifers, Contamination,

As part of an effort to monitor groundwater quality and to assess the potential for groundwater contamination on a statewide basis, central Lonoke County, Arkansas was chosen to represent an agri-cultural setting with heavy pesticide and fertilizer use. Water samples from 21 wells in the alluvial aquifer and 1 well each in the Sparta aquifer and Wilcox aquifer were analyzed for physical proper-ties, major inorganic constituents, nutrients, trace inorganic constituents, total organic carbon, and selected pesticides. With the exception of iron and manganese, the water in the alluvial aquifer generally did not exceed U.S. Environmental Protection Agency primary or secondary maximum contami-nant levels for drinking water. Although water containing high concentrations of iron and manga-nese is suitable for irrigation, some treatment for iron and manganese removal might be desirable for drinking water use. Dissolved solids concentra-tions in the alluvial aquifer ranged from 88 to 536 tions in the analysis adulter ranged from 8 to 350 mg/L with the higher concentrations occurring in the southern one-half of the study area. Of the pesticides tested for, once were detected in the alluvial aquifer. The potential for widespread groundwater contamination in the study area is low because of the relatively impermeable clay and silt deposits of the alluvial confining unit that over-lie the alluvial aquifer in most, if not all, of the study area. Potential contaminants include pesti-cides and nitrates originating from agricultural practices. (USGS) W91-09821

INTERRELATIONSHIPS BETWEEN CARBON-ATE AQUIFER SHALLOW CONDUIT FLOW AND POLLUTION POTENTIAL FROM SUR-FACE ACTIVITIES.

Kentucky Water Resources Research Inst., Lex-

Kentucky Water Resources Research Inst., Lexington.
L. V. Sendlein, G. K. Felton, J. Thrailkill, J. C. Currens, and J. S. Dinger.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-125344/AS. Price codes: A03 in paper copy, A03 in microfiche. Kentucky Water Resources Research Institute, Lexington, Research Report No. 177, September 1990. 31p, 2 tab, 7 fig, 5 ref, 3 append. USGS Contract No. 14-08-0001-G1564. USGS Project No. G1564-05.

Descriptors: \*Aquifers, \*Flow characteristics, \*Groundwater movement, \*Groundwater pollution, \*Karst, \*Kentucky, Data acquisition, Spring data, Water quality data, Well data.

The study represents an important step in the study of Kentucky karst systems. Through the establishment of an instrumented research groundwater basin with continuous measurements of a major spring and key stream discharges as well as the capacity for continuous water quality monitoring, the nature of a karst groundwater basin can be documented. Spring data are collected from a three foot H-flume erected on the Garrett Spring in Kessamipe and Woodford Couries Kentucijes. in Kessamine and Woodford Counties, Kentucky. Seven gaging stations have been located on the two major streams in the basin and one precipita-tion gage is currently located in the basin with two additional gages to be located in the near future. A geomorphic analysis of the basin includes sinkhole geomorphic analysis of the obasin includes sinkhole location and measurement. Water well data from 95 wells have been obtained and are currently being field checked. Spring discharge data has been collected for three months and only preliminary data are presented in the report. Discharges range from 4.8 1/s to more than 1110 1/s with a mean flow rate for the short period of measure-mean flow rate for the short period of measure-ment of 200 l/s. From ten water quality samples, total and suspended solids had means of 245 ppm and 20.6 ppm, respectively. Continued studies are planned for the basin. (Huffsey-U. KY-WRRI) W91-09827

PRELIMINARY EVALUATION OF THE EF-FECTS OF AN ABANDONED OIL REFINERY ON CHEMICAL QUALITY OF WATER IN THE ARKANSAS RIVER VALLEY, ARKANSAS ARKANSAS CITY, KANSAS, 1985-86.

Geological Survey, Lawrence, KS. Water Resources Div. T. B. Spruill. Available fro

1. D. Spruii. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4190, 1990. 53p, 18 fig, 13 tab, 28 ref. Project No. USGS KS 147

Descriptors: \*Alluvial aquifers, \*Contamination, \*Fate of pollutants, \*Groundwater pollution, \*Kansas, \*Oil wastes, \*Path of pollutants, Arkansas City, Oil refineries, Organic compounds.

Samples of ground water, wastes, waste leachate, and soil collected between December 1985 and August 1986 indicate that wastes from an abandoned oil refinery have caused local contamination of water in alluvium of the Arkansas River Valley in Kansas. The wastes have not affected major in Kansas. The wastest have not alrected major ionic composition of groundwater under the site except locally. Organic compounds are the principal contaminants; they are from the petroleum refinery wastes that affect water quality in the alluvium. Oil-contaminated sediments are the principal sources of hydrocarbons in groundwater under the site. Polynuclear aromatic compounds appear to pose the greatest environmental and public-health hazards. Limited detection of volatile organic compounds, at 3 micrograms per liter, in water from wells onsite and the general absence of organic compounds in water from wells offsite suggest that contaminants have been flushed from the aquifer, volatized, reacted to form other compounds, or have biodegraded. (USGS) W91-09832

CHARACTERIZATION OF GROUND-WATER FLOW AND CHEMICAL TRANSPORT BENEATH TWO IRRIGATED FIELDS IN SOUTH-

CENTRAL KANSAS, 1988. Geological Survey, Lawrence, KS. Water Resources Div.

sources Div.

A. T. Rutledge, and J. O. Helgesen.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Water-Resources Investigations Report 90-4065, 1990. 37p, 20 fig, 6 tab, 16 ref. USGS Project No. VS 135

Descriptors: \*Atrazine, \*Kansas, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, Root zone, Soil water.

Data pertaining to groundwater flow and chemical transport in the unsaturated and saturated zones beneath two irrigated fields in south-central Kansas were collected during 1988, with particular emphasis on the herbicide atrazine. A chloride-tracer test at one of the fields indicated that seepage velocity through a depth interval of about 6 to 10 ft in the unsaturated zone was about 4.6 ft/yr, and the maximum recharge during 1988 was 5 inches. Soil-water samples collected from the unsaturated zone at depths from about 6 to 10 ft saturated zone at depths from adout or to 10 in showed no definitive movement of atrazine. It is possible that the atrazine detected was applied before 1988, and that the 1988 atrazine application had not reached the 6-ft depth in 1988 because of retardation. Analyses of soil samples showed the largest concentrations of atrazine in the top 0.3 ft at a time when chloride (applied at the same time as the atrazine) had already reached a depth of 6 ft. A mathematical model shows that, below the root zone, atrazine follows a nonabsorbing tracer by approximately 1.2 years. In the saturated zone, concentrations of chloride, nitrite plus nitrate, and atrazine show stratification and decrease with increasing depth. (USGS) W91-09834

RELATION BETWEEN URBANIZATION AND WATER QUALITY OF STREAMS IN THE AUSTIN AREA, TEXAS. Geological Survey, Austin, TX. Water Resources

For primary bibliographic entry see Field 4C. W91-09835

NUTRIENTS, PESTICIDES, SURFACTANTS, AND TRACE METALS IN GROUND WATER

FROM THE HOWE AND MUD LAKE AREAS UPGRADIENT FROM THE IDAHO NATION-AL ENGINEERING LABORATORY.

Geological Survey, Idaho Falls, ID. Water Resources Div. D. D. Edwards, R. C. Bartholomay, and C. M.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Open-File Report 90-565, 1990. 19p, 1 fig, 9 tab, 17
ref. USGS Contract No. DE-AI07-81ID12306. USGS Project No. ID 165.

Descriptors: \*Water quality, \*Data collections, \*Groundwater, \*Chemical analysis, \*Monitoring, \*Idaho National Engineering Laboratory, Idaho, Snake River Plain aquifer.

Reconnaissance-level sampling for selected nutrients, pesticides and surfactants in groundwater up-gradient from the Idaho National Engineering aboratory was conducted during June 1989 Water samples collected from eight irrigation wells, five domestic or livestock wells, and two irrigation canals were analyzed for nutrients, herbicides, insecticides and polychlorinated compounds, and surfactants. In addition to the above constituents, water samples from one irrigation well, one domestic well, and one irrigation canal were analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Concentrations of nitrite plus nitrate as nitrogen ranged from less than the reporting level to 6.10 mg/L and ortho-phosphate concentrations as phosphorus ranged for less than the reporting level to 0.070 mg/L. Concentrations of 2,4-D in two water samples were 0.01 and 0.10 micrograms/L. Water samples analyzed from 15 other herbicides, 10 carbamate insecticides, 11 organophosphorus insecticides, and 15 organochlorine insecticides, gross polychlorinated biphenyls, and gross polychlorinated naphthalenes all had concentrations below their repo levels. Concentrations of surfactants ranged from 0.02 to 0.35 mg/L. Arsenic, barium, chromium, selenium, and silver concentrations exceeded reporting levels in most of the samples. (USGS) W91-09842

U.S. GEOLOGICAL SURVEY TOXIC SUB-STANCES HYDROLOGY PROGRAM: AB-STRACTS OF THE TECHNICAL MEETING, MONTEREY, CALIFORNIA, MARCH 11-15,

Geological Survey, Reston, VA. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 91-88, 1991. 133p. Compiled by G. E. Mallard and D. A. Aronson.

Descriptors: \*Groundwater pollution, \*Water pollution sources, \*Path of pollutants, \*Toxic wastes, \*Water pollution effects, \*Environmental effects, \*Nonpoint pollution sources, Hydrology, Toxic

The short, one-page abstracts give the latest results of research conducted by the USGS Toxic Substances Hydrology Program, which provides earth-science information needed to understand the movement and fate of hazardous substances in the groundwater and surface water of the Nation. The abstracts cover a wide range of topics that include results of site specific studies, nonpoint source con-taminants, and development of new analytical taminants, and development of new analytical methods and sampling techniques. (USGS)

EFFECT OF SPRAY IRRIGATION OF TREAT-ED WASTEWATER ON WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM, REEDY CREEK IMPROVEMENT DISTRICT, CEN-TRAL FLORIDA.

Geological Survey, Orlando, FL. Water Resources

For primary bibliographic entry see Field 5E.

# Sources Of Pollution-Group 5B

GEOLOGY, HYDROLOGY, AND WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM IN VOLUSIA COUNTY, FLORIDA. Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09846

HISTORY OF GROUND-WATER CONTAMINATION AND SUMMARY OF GROUND-WATER INVESTIGATIONS THROUGH 1985 AT FOUR INDUSTRIAL SITES, LOGAN TOWNSHIP, NEW JERSEY.

TOWNSHIP, NEW JERSEY.
Geological Survey, Trenton, NJ. Water Resources
Div.
J. C. Lewis, and J. J. Hochreiter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Open-File Report 90-102, 1990. 39p, 4 fig, 5 tab, 23

Descriptors: \*Coastal plain, \*New Jersey, \*Gloucester County, \*Water pollution sources, \*Waste disposal sites, \*Industrial wastes, Hazard-ous wastes, Oil wastes, Organic compounds. Jersey,

Investigations of potential sources of groundwater contamination conducted by various regulatory agencies and consultants at four industrial sites in Logan Township, New Jersey found groundwater contamination at all four sites and at properties adjoining two of the sites. The four sites directly excellent the Potence Pacifics Meachly assuifer. aujoining two the sites. The four site streetly overlie the Potomac-Raritan-Magothy aquifer system, the Township's sole source of potable water. One site was a waste-oil processing and storage facility. The major source of groundwater contamination at the site is a lagoon containing waste oil. Groundwater within 1,000 ft of the lagoon is contaminated. The second site is used to maintain, dispatch, and clean chemical-transporta-tion tanks. Potential sources of groundwater con-tamination at the site include former wastewater tamination at the site include former wastewater lagoons, leaking storage drums, and leaking tank trucks. Groundwater at and immediately north of the property is contaminated. Organic compounds are manufactured at the third site. Potential sources of groundwater contamination at this site include landfilled industrial wastes. Groundwater underlying the property is contaminated, but there is no evidence of offsite groundwater contamination from this source. The fourth site is used to treat and dispose of hazardous wastes. The major source of groundwater contamination at this site is landfilled residue from waste-treatment processes. landfilled residue from waste-treatment processes. Groundwater underlying the property is contaminated, but there is no evidence of off-site groundwater contamination from this source. (USGS) W91-09848

EXTENT AND SOURCE OF ORGANIC SOLVENTS IN GROUND WATER IN THE ARGONNE ROAD AREA NEAR SPOKANE, WASHINGTON. Geological Survey, Tacoma, WA. Water Re-

sources Div.

N. P. Dion, and S. S. Sumioka. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4121, 1991. 39p, 8 fig, 6 tab, 44 ref.

Descriptors: \*Groundwater pollution, \*Organic solvents, \*Washington, \*Spokane, \*Path of pollutants, \*Water pollution sources, \*Aquifers, Wells, Sludge.

An alluvium-filled trough cut into granite near Spokane, Washington, contains an unconfined groundwater body that is hydraulically connected to the 'sole-source' Spokane aquifer to the south. In the spring of 1981, water in the alluvial aquifer was found to contain the discoluted graniting. was found to contain the dissolved organic solvents tetrachloroethane, trichloroethene, 1,1,1vents tendendered in the introduced in the state of the superior than the superior that the superior that the superior that the solvents have reached the Spokane aquifer; however, water in two wells in that aquifer immediately downgra-dient of the alluvial aquifer does not contain the solvents. Therefore, the solvents either have not yet reached the susceptible wells, or concentra-

tions have been diluted to below minimum analytical detection levels. The Spokane aquifer wells likely to be affected are few in number, but serve about 2,600 people. (USGS) W91-09852

QUALITY OF GROUND WATER IN CLARK COUNTY, WASHINGTON, 1988. Geological Survey, Tacoma, WA. Water Re-sources Div. G. L. Turney. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225, USGS Water Resources Investigations, Report 90.4149. Water-Resources Investigations Report 90-4149, 1990. 97p, 15 fig, 11 tab, 30 ref.

Descriptors: \*Groundwater pollution, \*Water quality, \*Nitrates, \*Organic compounds, \*Clark County, \*Washington, Water quality standards.

Water samples were collected from 76 wells throughout Clark County, in southwest Washington, during April and May 1988, and were analyzed from concentrations of major ions, silica, nitrate, phosphorus, aluminum, manganese, radon, and bacteria. Samples from 20 wells were analyzed for concentrations of trees alexed. and bacteria. Samples from 2.0 wells were analyzed for concentrations of trace elements and organic compounds, including most of those on the U.S. Environmental Protection Agency (USEPA) priority pollutant list. Dissolved solids concentrations range from 12 to 245 mg/L, with a median concentration of 132 mg/L. The major dissolved constitutration of 132 mg/L. The major dissolved constitu-ents are calcium, bicarbonate, and silica, and, in some samples, sodium. Nitrate concentrations ex-ceeded 1.0 mg/L throughout the Vancouver urban area, and were as large as 6.7 mg/L. Comparison with limited historical data indicates that nitrate concentrations may be decreasing in urban areas, but increasing in rural areas. Nitrate and sulfate concentrations were somewhat correlated, possibly indicating similar sources, such as sentic systems concentrations were somewant correlated, possibly indicating similar sources, such as septic systems and fertilizers. Volatile organic compounds, including tetrachloroethane and 1,1,1-trichloroethane, were detected in samples from three wells in the Vancouver area. Trace amounts of volatile organic compounds were reported in samples from several other wells, but at concentrations too close to analytical detection limits to ascertain that they were in the groundwater. Atrazine was detected in a sample from one well and 2,4-D was detected in samples from two wells. No other organic comsampies from two wells. No other organic compounds were detected. Trace elements and radio-chemical constituents were present at small levels indicating natural sources for these constituents. Only pH, turbidity, iron, manganese, and total coliform bacteria had values that did not meet USEPA Drinking Water Standards. (USGS)

EVALUATION AND DESIGN OF GEOPHYSICAL MONITORING NETWORK FOR GROUNDWATER CONTAMINATION.
Nebraska Univ.-Lincoln. Dept. of Civil Engineer-

For primary bibliographic entry see Field 7A. W91-09861

GROUNDWATER CONTAMINATION IN THE UNITED STATES.

Geological Survey, Reston, VA. Water Resources

Div.
D. W. Moody.
Journal of Soil and Water Conservation JSWCA3,
Vol. 45, No. 2, p 170-179, 1990. 28 ref.

Descriptors: \*Drinking water sources, \*Ground-water pollution, \*Groundwater quality, \*Nitrates, \*Path of pollutants, \*Public health, \*Risk assess-ment, \*Shallow aquifers, \*Water quality standards, Detection limits, Model studies, Monitoring, Re-rescrib principite, Studies, companying search priorities, Synthetic organic compounds

Evidence concerning the extent and severity of groundwater contamination suggests that the shallowest aquifers generally are at greatest risk of contamination and that contamination by nitrates and synthetic organic chemicals is widespread in many areas. Other than in the vicinity of point source plumes, the concentrations of contaminants usually are well below existing health advisories

and commonly are at minimum levels of detection. An exception is intrate-nitrogen which exceeds the federal drinking water standard of 10 ppm in about six percent of wells sampled nationwide, although locally the percentage of wells may be much higher. The health risks of chronic, long-term exposure to such small concentrations is unknown. Deeper aquifers which are commonly used for public drinking water supplies, appear to be relatively free from contamination. Better quantitative assessments of groundwater quality is dependent upon improvements in the models used to predict contaminant behavior, the implementation of monitoring programs, the use of standard sampling and and commonly are at minimum levels of detection. toring programs, the use of standard sampling and analytical procedures and research on the health risks associates with long-term exposure to very small concentrations of contaminants. (Author's abstract) W91-09866

AGRICULTURAL. CHEMICALS AND GROUNDWATER QUALITY.

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.

H. Bouwer.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 184-189, 1990. 51 ref.

Descriptors: "Agricultural chemicals, "Environmental policy, "Groundwater pollution, "Groundwater quality, "Legislation, "Nitrates, "Nonpoint pollution sources, "Pesticides, "Water pollution sources, Economic aspects, Public health, Water policy, Water pollution effects, Water pollution management, Water pollution prevention, Water pollution treatment, Water quality standards.

Agricultural chemicals of concern in groundwater quality degradation are nitrate and pesticides. Too much nitrate in drinking can cause methemoglobinemia (blue baby disease) in infants and may also increase cancer in the population as a whole. There increase cancer in the population as a whole. There is an association between ingestion of certain specific pesticide residues and health problems such as cancer, nervous system disorders, birth defects and male sterility. A recent report by the Public Interest Research Group using U. S. EPA data indicates that, of 45,000 wells (primarily located in problem areas) tested for pesticides, 5500 had harmful levels of at least one pesticide. Another 5500 had traces of at least one pesticide. Another 5500 had traces of 73 different pesticides in amounts not considered harmful, including 25 that can cause cancer, 18 that can cause birth defects, and 14 that can cause that can cause birth defects, and 14 that can cause genetic damage. Some proposed legislation is draconian, such as California's Proposition 65, which could have dramatic effects on agriculture. Under Proposition 65 the use of some pesticides will be banned. Most states now have groundwater protection legislation enacted or proposed. Federal legislation ranges from stressing regulation to stressing research. Maximum permissible concentrations of toxic chemicals in promoturate and in stressing feature. Maniful permission concern trations of toxic chemicals in groundwater and in drinking water typically are determined by labora-tory and animal studies, with all its uncertainties and shortcomings. Prevention of groundwater pollution is much cheaper than restoring polluted aquifers. Agriculture, industry academia, health professionals, policymakers, and environmentalists must work together to assess the real risks associated with agricultural contaminants and develop management policies and practices that strike a balance between public health, environment, and economics. (Feder-PTT) W91-09868

AGRICULTURAL BEST MANAGEMENT PRACTICES AND GROUNDWATER PROTEC-

Ohio State Univ., Columbus. Dept. of Agronomy. For primary bibliographic entry see Field 5G. W91-09872

BLAMELESS CONTAMINATION: NEW STATE LEGISLATION REGULATING LIABILITY FOR AGRICULTURAL CHEMICALS IN GROUNDWATER.

Georgia Agricultural Experiment Stations, Athens. For primary bibliographic entry see Field 6E. W91-09875

# Group 5B-Sources Of Pollution

FARMER LIABILITY FOR PESTICIDE CON-TAMINATION OF GROUNDWATER IN CON-NECTICUT.

Connecticut Univ., Storrs. Dept. of Agricultural

and Resource Economics. For primary bibliographic entry see Field 6E. W91-09876

# GIS-BASED APPROACH TO EVALUATING REGIONAL GROUNDWATER POLLUTION POTENTIAL WITH DRASTIC.

Geo Decisions, Inc., P.O. Box 1028, Lemont, Pennsylvania 16851.

For primary bibliographic entry see Field 7C. W91-09882

ENVIRONMENTAL REGULATION OF AGRI-CULTURE IN ARIZONA. Arizona Dept. of Environmental Quality, Phoenix. For primary bibliographic entry see Field 5G. W91-09884

# NITRATE-NITROGEN LOSSES TO GROUND-WATER FROM RURAL AND SUBURBAN

LAND USES.
Rhode Island Univ., Kingston. Dept. of Natural

Rnode Island Univ., Kingston. Dept. of Natural Resources Science. A. J. Gold, W. R. DeRagon, W. M. Sullivan, and J. L. Lemunyon. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 305-310, 1990. 1 fig, 3 tab, 30 ref. Soil Conservation Service cooperative agreement

Descriptors: \*Groundwater pollution, \*Land use, \*Nitrates, \*Path of pollutants, \*Rhode Island, \*Ursanization, \*Water pollution sources, Agricultural runoff, Fertilizers, Lawns, Rural areas, Septic wastewater, Suburban areas

Nitrate-nitrogen (nitrate-N) losses to groundwater from septic systems, forests, home lawns, and urearoom sepace systems, torests, nome nawns, and utrea-, and manure-fertilized silage corn were quantified and compared during a 2-year study. The septic system and all silage corn treatments had annual flow-weighted concentrations of nitrate-N in excess of 10 mg/L for at least 1 of the 2 years. In contrast, the forest and both fertilized and unfertilized home lawn treatments generated flow-weighted nitrate-N concentrations of less than 1.7 mg/L. Annual losses ranged from greater than 70 kg/ha of nitrate-N from silage corn treatments to less than 1.5 kg/ha from unfertilized home lawns and forest. The results demonstrate the importance of unfertilized land use types in maintaining aquifer water quality; they also suggest that replacing pro-duction agriculture with unsewered residential development will not markedly reduce nitrate-N losses to groundwater. (Author's abstract) W91-09900

# PATTERNS OF SOIL NITRATE AVAILABIL-ITY IN CORN PRODUCTION SYSTEMS: IM-PLICATIONS FOR REDUCING GROUNDWAT-ER CONTAMINATION.

Maryland Univ., College Park. Dept. of Agricultural Engineering.
K. W. Staver, and R. B. Brinsfield.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 318-323, 1990. 3 fig. 3 tab, 46 ref. USDA Law Input Sustainable Agriculture Pro-gram Contract No. 88-Coop-13524.

Descriptors: \*Groundwater pollution, \*Nitrates, \*Nonpoint pollution sources, \*Water pollution control, \*Water pollution sources, Agricultural practices, Chesapeake Bay, Corn, Crop production, Fertilization, Path of pollutants, Soil chemistry, Ellicase try, Tillage.

In the Coastal Plain region of the Chesapeake Bay drainage basin, lateral groundwater discharge appears to be the major transport pathway of nitrogen (N) from cropland into estuarine waters. Soil nitrate concentrations in nonirrigated corn production systems were investigated under differing fer-tilization and tillage practices, as well as in the presence and absence of a rye winter cover crop. Following a brief period of corn nitrogen use, the

microbial process increased soil nitrate levels dramicrobial process increased soil nitrate levels Gra-natically. Autumn soil nitrate levels increased as growing season N application rates increased, but were highest in unfertilized fallow treatments. Growth by rye cover crops planted immediately after corn harvest responded positively to increas-ing nitrate availability in the root zone and cover rop uptake removed a major percentage of pore water nitrate from the upper region of the soil profile prior to the onset of the groundwater re-charge period. The use of cereal grain winter cover crops may offer an effective management alternative to more drastic measures, such as removing farmland from production or restricting N fertilization rates, for reducing groundwater nitrate contamination and subsurface transport of N into Chesapeake Bay. (Author's abstract) W91-09903

# LANDOWNER PERCEPTIONS OF SINK-HOLES AND GROUNDWATER CONTAMINA-

Iowa Natural Heritage Foundation, Des Moines. For primary bibliographic entry see Field 5G. W91-09904

# NUTRIENT LOSS VIA GROUNDWATER DIS-CHARGE FROM SMALL WATERSHEDS IN SOUTHWESTERN AND SOUTH CENTRAL WISCONSIN.

Wisconsin Dept. of Natural Resources, Fitchburg. Bureau of Research.

J. W. Mason, G. D. Wegner, G. I. Quinn, and E.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 327-331, 1990. 3 fig, 4 tab, 19 ref.

Descriptors: \*Nutrient transport, \*Path of pollutants, \*Small watersheds, \*Surface-groundwater relations, \*Water pollution sources, \*Wisconsin, Agricultural chemicals, Fertilizers, Nitrogen, Nutrient concentrations, Phosphorus, Water quality trends.

Nitrogen (N) and phosphorus (P) levels in the base flow discharge of 10 small streams in south central and southwestern Wisconsin were measured in 1988-1989 and compared to historical data on the same streams. Nitrate concentrations had increased significantly in three streams. Nitrate concentrations appear to be related to agricultural activities and fertilizer use in the watersheds. Highest nitrate levels have been found in the area south of the Wisconsin River where land use changes have occurred. Current P levels in the 10 streams were established, but trends could not be determined because of the unreliability of the historical data set. (Author's abstract) W91-09905

# LONG-TERM PATTERNS IN SPRING WATER QUALITY: AN APPROACH TO GROUNDWAT-ER EDUCATION PROGRAMS FOR RURAL COMMUNITIES.

Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Fisheries and Wildlife Sciences. For primary bibliographic entry see Field 2F. W91-09906

# EXPERT OPINION AND GROUNDWATER QUALITY: THE CASE OF AGRICULTURAL DRAINAGE WELLS.

Minnesota Univ.-Duluth. Dept. of Geography. G. A. Tobin, and R. Rajagopal.

Journal of Soil and Water Conservation JSWCA3,
Vol. 45, No. 2, p 336-340, 1990. 20 ref.

Descriptors: \*Agricultural runoff, wells, \*Groundwater pollution, \*Groundwater quality, \*Path of pollutants, \*Water pollution control, \*Water pollution sources, Agricultural chemi-

Productive farming in parts of the Midwest de-pends upon agricultural drainage wells to maintain favorable soil moisture levels. These wells channel water and, it is hypothesized, chemical pollutants into aquifers. The number of functioning wells is not known, nor is their spatial distribution, although they are apparently clustered in areas with

poor drainage. Current evidence indicates groundwater contamination occurring only at local levels. The Iowa Department of Natural Resources has The rown Department of valual resources has recommended phasing out these wells through various incentive programs. As part of a larger project, a survey questionnaire was developed to elicit opinions from 100 groundwater experts on how to deal with drainage wells. Results demonstrated some of the complexities of implementing strated some of the complexities of implementing environmental policies based on incomplete information. The consensus was toward greater controls, although appropriate strategies to be adopted and sources of funding for implementing management policies were open to debate. There were calls for further research, particularly to determine the socioeconomic impacts of closing drainage wells. (Author's abstract) W91-09907

# LONG-TERM FIELD RESEARCH ON WATER AND ENVIRONMENTAL QUALITY.

Agricultural Research Service, Durant, Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 5C. W91-09911

# ACCUMULATION OF ZINC AND COPPER IN MOLLUSCS FROM THE ZEGRZYNSKI RES-ERVOIR AND THE NAREW RIVER.

Polish Academy of Sciences, Lomianki. Dept. of Hydrobiology.

For primary bibliographic entry see Field 2H.

# HYDROBIOLOGICAL CHARACTERISTIC OF THE LOWLAND, RHEOLIMNIC WLOCLAWEK RESERVOIR IN THE VISTULA RIVER.

Nicholas Copernicus Univ. of Torun (Poland). Dept. of Hydrobiology. For primary bibliographic entry see Field 2H.

# WATER QUALITY CLASSIFICATION OF THE VISTULA RIVER BASIN IN 1987. Institute of Meteorology and Water Management,

Marsaw (Poland). Dept. of Water Chemistry.

J. Dojlido, and J. Woyciechowska.

Ekologia Polska ELPLBS, Vol. 37, No. 3/4, p.
405-417, 1989. 6 fig., 7 tab, 5 ref.

Descriptors: \*Path of pollutants, \*Poland, \*Water quality standards, Eutrophication, Inorganic salts, Nitrogen, Nonpoint source pollution, Nutrients, Organic pollutants, Phosphorus, Vistula River, Wastewater pollution, Water chemistry, Water

Water pollution of the rivers within the Vistula drainage basin was analyzed and classified in 1987 based on the four water classification in Poland: (I) based on the four water classification in Poland: (I) drinking water supply, (II) recreation, fish breeding, (III) industrial plants supply, irrigation, and (IV) none. Water samples were obtained and analyzed by regional laboratories with an average frequency of 12 times per year. Analytical results were used to prepare hydrochemical curves, showing changes of each pollutant concentration along the river course. The measurements were compared with permissible concentrations for each class. The waters in the Silesia, Wieprz, Bug, Bzura, Drweca and Vistula up to Wloclawek were the most polluted by organic pollutats and phosenters. the most polluted by organic pollutants and phosphates. The upper part of the Vistula was polluted with inorganic salts discharged mainly from the coal mines. Other sources of pollution are sewage and unsatisfactorily treated wastewater discharge. High nutrient contents of the sewage and high righ nutrient contents of the sewage and figh concentrations of nitrogen and phosphorus from non-point sources has added to the problem of an increased rate of eutrophication. This growing water pollution problem will endanger the econo-my and health of the nation. (Medina-PTT) W91-09927

ACCUMULATION OF METAL TRACERS BY MYTILUS EDULIS. RADIO.

### Sources Of Pollution-Group 5B

International Lab. of Marine Radioactivity, Monaco-Ville (Monaco). For primary bibliographic entry see Field 5A. W91-09928

# DIFFUSION IN SATURATED SOIL, I: BACK-

Colorado State Univ., Fort Collins. Dept. of Civil

Engineering. C. D. Shackelford, and D. E. Daniel. Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 3, p 467-484, March 1991. 4 fig., 4 tab, 53 ref. EPA Cooperative Agreement

Descriptors: \*Diffusion, \*Diffusion coefficient, \*Groundwater movement, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Saturated soils, \*Underground waste disposal, \*Waste disposal, Clays, Compacted soils, Inorganic compounds.

Recent studies suggest that diffusion may be an important, if not dominant, mechanism of contaminant transport through waste containment barriers. The measurement of diffusion coefficients of inorganic chemicals diffusing in saturated soil was investigated. Both steady-state and transient equations are used to describe the diffusive transport of inorganic chemicals. Several factors affecting diffusional management of the statement of the several factors affecting diffusional management. tions are used to describe the diffusive transport of inorganic chemicals. Several factors affecting diffusion coefficients have been identified including a reduction in the cross-sectional area of flow, the tortuosity of the soil, the effects of soil geometry and fluidity, and anion exclusion from the smaller pores of the soil. A method for measuring diffusion coefficients for compacted clay soil is presented. The definition of the diffusive coefficient for diffusion in soil (known as the effective diffusion coefficient. D) is shown to vary widely. In general cient, D) is shown to vary widely. In general, variations in the definition of D result from consideration of the different factors that influence diffu-sion of solutes in soil and the different ways of including the volumetric water content in the governing equations. Effective diffusion coefficients can be measured in cells in which compacted soils are first presoaked to eliminate suction that would cause mass transport via advection and then exposed to a reservoir of leachate and later sectioned to determine the distribution of diffusing solutes at the end of the test. Effective diffusion coefficients can be determined either from the rates of decrease of solute concentrations in the reservoir or from the final concentration profiles of solutes in the soil. (See also W91-09940) (Medina-PTT) W91-09939

# DIFFUSION IN SATURATED SOIL. II, RE-SULTS FOR COMPACTED CLAY,

Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
C. D. Shackelford, and D. E. Daniel.

Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 3, p 485-506, March 1991. 12 fig. 7 tab, 39 ref. U. S. EPA Cooperative Agreement CR812630-01.

Descriptors: \*Clays, \*Compacted soils, \*Diffusion, \*Diffusion coefficient, \*Groundwater movement, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Saturated soils, \*Underground waste disposal, \*Waste disposal, Anions, Bromine, Cadmium, Cations, Chlorine, Iodine, Kaolinite, Leachates, Lufkin clay, Potassium, Zinc.

The effective diffusion coefficients, D, of three anions Br(-1), Cl(-1), and I(-1) and three cations Cd(+2), K(+1), and Zn(+2) diffusing in two compacted clay soils, kaolinite and Lufkin clay, were measured. The ions were contained in a simulated waste leachate. The effects of molding simulated waste leachate. simulated waste leachate. The effects of molding water content and method of compaction on the measured D values were evaluated for kaolinite. The calculated D values varied between 40 sq nano-m/s and 2 sq nano-m/s and, based on the results for chloride diffusion in kaolinite, are relatively insensitive to molding water content and compaction method. The measured D values for Cl(-1) and Br(-1) in kaolinite are in excellent agreement with previous studies, but the D values for the cations are relatively high. High D values for the cations are attributed to nonlinear adsorption the cations are attributed to nonlinear adsorption behavior at relatively high concentrations and to

the possibility of chemical precipitation of the heavy metal species Cd(+2) and Zn(+2). Also, D values determined from reservoir concentrations typically are higher than D values determined from soil concentration profiles. (See also W91-09939) (Author's abstract) W91-09940 W91-09940

# SPATIAL SCALE DEPENDENCE OF IN SITU SOLUTE TRANSPORT.

Guelph Univ. (Ontario). Dept. of Land Resource For primary bibliographic entry see Field 2G. W91-09960

CLAY MINERAL TYPE AND ORGANIC COM-POUND SORPTION BY HEXADECYLTRI-METHYLAMMONIUM-EXCHANGED CLAYS. Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.

and Soil Sciences.

W. F. Jaynes, and S. A. Boyd.
Soil Science Society of America Journal SSSID4,
Vol. 55, No. 1, p 43-48, January/February 1991. 5
fig, 3 tab, 20 ref. U.S. Geological Survey, award
no. 15-08-0001G; National Institute of Environmental Health Sciences, award no. 1 P42 ES04911
01.

Descriptors: \*Adsorption, \*Clay minerals, \*Clay soils, \*Ion exchange, \*Organic compounds, \*Path of pollutants, \*Soil chemistry, Benzenes, Biphenyl, Cations, Illite, Kaolinite, Naphthalenes, Smectite, Toluene, Vermiculite, X-ray diffraction

In order to relate minerology to sorbent efficiency, organo-clays were prepared from reference vermiculite, illite, smectite, and kaolinite clay minerals miculte, illite, smectite, and kaolinite clay minerals using the organic cation hexadecyltrimethylammonium (HDTMA). Adsorption isotherms using 14-C-HDTMA indicated stoichiometric adsorption of HDTMA up to the cation-exchange capacity (CEC). Organo-clays were prepared by adding HDTMA equivalent to the CEC and were evaluated as a contraction of the capacity of the contraction of the capacity of th HDTMA equivalent to the CEC and were evaluated as sorbents for nonionic organic compounds (NOCs) dissolved in water. X-ray diffraction analysis of the HDTMA clays revealed basic spacings of 28 angstroms for the vermiculite and 23, 20, and 18 angstroms for the high-charge intermediate-charge, and low-charge smectites, respectively. The HDTMA vermiculite, illite, and smectites were all highly effective sorbents for NOCs, whereas Mg smectite was ineffective. The sorption isotherms of benzene, toluene, ethylbenzene, propylbenzene, butylbenzene, t-butylbenzene, naphthalene, and biphenyl on the HDTMA clays indicated that sorption occurred by partition interactions with the HDTMA-derived organic phase. In general, both the greater HDTMA content and the larger basal spacings of high-charge HDTMA clays increased NOC sorption. Mineral-charge effects on the sorption of unsubstituted aromatic compounds (benzene, naphthalene, and biphenyl) were less evident than for alkyl-benzenes. Greater sorption of the alkylbenzenes by high-charge were less evident than for anyt-energies. Greater sorption of the alkylbenzenes by high-charge HDTMA clays can be attributed to the capability of the large basal spacings to accommodate larger solute molecules. The formation of organic cation exchanged soil clays derived from vermiculite, illies or specific may greatly improve the ability. illite, or smectite may greatly improve the ability of soils to immobilize organic contaminants. (Author's abstract) W91-09963

# ACIDIFICATION INDUCED BY DIFFERENT NITROGEN SOURCES IN COLUMNS OF SE-LECTED TROPICAL SOILS.

International Fertilizer Development Center, Muscle Shoals, AL. J. M. Stumpe, and P. L. G. Vlek. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 145-151, January/February 1991. 3 fig, 5 tab, 25 ref.

Descriptors: \*Acidic soils, \*Acidification, \*Fertilizers, \*Soil types, \*Tropical regions, \*Water pollution sources, Aluminum, Ammonium sulfate, Calcium ammonium nitrate, Leachates, Manganese, Soil management, Ureas,

Sustainability in agriculture is a rising concern in the tropics where fertilizers are introduced to meet

increasing food demands. The adverse effects of long-term fertilizer use were monitored through changes in the soil exchange complex in packed columns of an Oxic Paleustalf, a Typic Paleudult, and Tropeptic Haplustox. Following each application of N at rates of 0, 50, or 100 kg/ha as urea, ammonium sulfate, or calcium ammonium nitrate, the soils were flushed with distilled water, representing the water draining from these soils in their respective tropical environments during a growing season. The procedure was repeated 30 times during 2 yr with 6-wk rest periods after each 5 cycles. The rate of acidification reflected the rate of application and acid-producing capacity of the N source. In the Oxisol and Ultisol, further acidification resulted in an increase in exchangeable Al increasing food demands. The adverse effects of cation resulted in an increase in exchangeable Al and Mn, which were eventually found in the efflu-ent, suggesting mineral dissolution. In the Alfisol, ent, suggesting mineral dissolution. In the Alfisoi, acidification resulted in a loss of cation-exchange sites and the increasing predominance of Al and Mn. This acid-consuming process caused the development of a descending acidification front, in which soil pH dropped from 6.7 to 5.0. Leachates remained neutral until the acidification front reached the bottom of the soil column. Applied N was quantitatively recovered in the leachates of all soils. Although plant growth would moderate was quantitatively recovered in the leadings of an soils. Although plant growth would moderate these processes, the results show that indiscriminate N use on such soils may eventually cause soil degradation and groundwater pollution. (Author's abstract) W91-09965

# UNIQUE SOIL-CARBONATE LIBERATION TECHNIQUE FOR USE WITH CARBON-14-LA-BELED CARBONATE.

Atomic Energy of Canada Ltd., Pinawa (Manito-ba). Whiteshell Nuclear Research Establishment. For primary bibliographic entry see Field 7B. W91-09974

# EFFECT OF TEMPERATURE ON THE CHRONIC TOXICITY OF ARSENATE TO RAINBOW TROUT (ONCORHYNCHUS MYKISS).

Waterloo Univ. (Ontario). Dept. of Biology. For primary bibliographic entry see Field 5C. W91-09996

# TRANSPORT MODELLING IN WATERSHEDS. Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides. For primary bibliographic entry see Field 7C. W91-10007

# EVALUATION OF GROUNDWATER FLOW CONDITIONS IN THE SAN GABRIEL BASIN, CALIFORNIA, USING A THREE DIMENSION-AL NUMERICAL MODEL.

CH2M Hill, Santa Ana, CA. For primary bibliographic entry see Field 2F. W91-10035

# CHERNOBYL ACCIDENT RAISES A CONCERN REGARDING THE PROTECTION OF GROUND WATER.

Leighton and Associates, Inc., Irvine, CA. G. E. Heim.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p G10-G13. 2

Descriptors: \*Chernobyl, \*Environmental policy, \*Groundwater pollution, \*Nuclear accidents, \*Radioactive wastes, \*Water pollution sources, Contingency planning, Geohydrology, Groundwater movement, Groundwater quality, Hazardous materials, Monitoring, Nuclear powerplants, Nuclear reactors, Radioactivity, USSR.

The April 26, 1986 accident at the Chernobyl nuclear reactor raised many critical technical issues. A consultant group convened by the International Atomic Energy Agency of the United Nations Organization, Vienna, Austria is preparing a guidance manual addressing the following topics: the sources of radioactivity, the geohydrological

### Group 5B-Sources Of Pollution

and transport models that should be developed to provide the data necessary to select and design preventive and/or mitigative measures, the preven-tive and mitigative techniques, the recommended groundwater monitoring program, and the quality assurance requirements for the performance of all assurance requirements for the periodinate of an activities. The manual recommends that owners of nuclear power plants assess the options of selecting, designing, installing, and operating either: (1) preventive systems to contain within the site boundary accidental releases of radioactive materials. al into the groundwater system; or (2) mitigative systems to be used in the case of an accidental release. The preventive and/or mitigative measures considered include: (1) well systems; (2) subsurface considered include: (1) weir systems; (2) substitute (drains; (3) air vacuum system; (4) barrier walls; and (5) infiltration barriers. There are several lessons to be learned from the Chernobyl accident that can be applied to facilities where radioactive materials or hazardous chemicals are present. These lessons include: (1) the installation of systems to prevent offsite releases prior to the operation of a facility is the best assurance of minimizing the affects of an accidental release of radioactive or hazardous maaccidental release of randoctive or nazardous ma-terials on the groundwater system; (2) the data pertaining to the groundwater system at many facilities where radioactive or hazardous chemicals are present, are insufficient to select and design are present, are insulticent to select and uesgin containment systems in advance; (3) radioactive materials decay with time; (4) recognize the impor-tance of defining natural systems which may be affected by an accident; (3) the importance of artected by an accident; (3) the importance of groundwater monitoring systems; and (6) emergency response plans for users of radioactive and hazardous chemicals should include the identification of contrators who can install remedial systems compatible with the subsurface site conditions. (See also W91-10018) (Kern-PTT) (See also W W91-10044

MODELING THE VERTICAL TRANSPORT AND FATE OF LOW-WATER SOLUBILITY TOXIC CHEMICALS IN A SHALLOW UNCON-FINED AQUIFER.

Oregon State Univ., Corvallis. Dept. of Mathemat-

ics.
F. T. Lindstrom, and L. S. Slotta.
F. T. Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p G14-G20. 9 fig, 4 tab, 27 ref.

Descriptors: \*Mathematical models, \*Model studies, \*Path of pollutants, \*Solubility, \*Solute transport, \*Unconfined aquifers, Adsorption, Aquifers, Data interpretation, Differential equations, Dispersion, Finite element method, Heat flow, Hydraulic properties, Unsaturated flow, Vertical distribution.

Adsorption, dispersion and changes in moisture content control the rate of solute transport in an unsaturated soil column. A one-dimensional model has been developed to examine the simultaneous transport of heat, moisture and chemical mass in unsaturated soils; chemical concentration is assumed to be low. The field equation for chemical transport is strongly coupled to the field equations for moisture content and temperature while the converse is not true. Vertical temperature, moisconverse is not true. Vertical temperature, mois-ture content and chemical concentration profiles were determined using the iterative Thomas algo-rithm procedure on implicit backward Galerkin finite element approximations to the defining set of nonlinear partial differential equations. For a speci-fied set of hydraulic properties, initial distributions of chemicals in the soil column and external weath-er conditions, chemical concentration profiles for 100 days simulations illustrated the influence of the 100-days simulations illustrated the influence of the combined effects of adsorption and dispersion on chemical transport in unsaturated soils. Numerical chemical transport in unsaturated soils. Numerical dispersion was minimized by keeping nodal spacing small in the vicinity of steep gradients of moisture content, temperature and chemical concentration. Numerical dispersion occurred more frequently in the solution of chemical transport, particularly when dispersivities were low. (See also W91-10018) (Author's abstract)

LOADING AND OVERFLOW OF DREDGE SCOWS AND HOPPERS.

Army Engineer Waterways Experiment Station.

Vicksburg, MS. Environmental Lab. M. R. Palermo. Army Corps of Engineers Information Exchange Bulletin, Vol. D-90-2, August 1990. p 1-5, 1 tab, 3

Descriptors: \*Dredging, \*Dredging wastes, \*Over-flow, \*Waste disposal, \*Water pollution sources, Environmental effects, Ocean dumping, Regula-tions, Suspended solids, Turbidity.

Dredge hoppers and scows are commonly filled past the point of overflow to increase the load. The past the point of overflow in orderse the load. The two major issues/questions relating to overflow are: whether a load gain can be realized (and an economic load subsequently determined) if overflow is used under a given set of operational conditions; and, the characteristics of the overflow and the potential environmental effects due to turbidity or presence of contaminants. The decision to allow, restrict, or prohibit overflow in a given case should be based on an evaluation of these questions. Unfortunately, arriving at a decision requires an evaluation of the trade-offs between potential an evaluation of the trade-offs delivered potential economic benefits and potential environmental effects. The degree to which a load gain can be achieved by overflow of a hopper or scow is dependent on the characteristics of the material being dredged, the method of dredging (hydraulic or mechanical), and the design of the equipment used. Although a number of theoretical studies, model studies, and field tests have been conducted, no routinely applied method is available to predict the potential load gain achieved by overflow under a given set of conditions. The concentrations of a given set of conditions. The contentiations assuspended solids in the overflow depends on the same parameters as the potential load gain. The higher the relative gain in load, the lower the solids concentration in the overflow. The subsequent extent of water column turbidity and bottom deposition due to overflow is dependent on site-specific hydrodynamic conditions. Technical infor-mation is related to the economic loading of hopper dredges and scows and the characteristics of overflow are limited. Additional guidance is needed when overflow can potentially achieve load gains. Equipment and techniques are needed to improve the efficiency of retention of material in hoppers and scows, and to predict the potential load gain in hoppers and scows under various conditions. (Lantz-PTT) W91-10065

SCOPE AND ASSESSMENT OF AQUATIC EF-FECTS DUE TO ACIDIC DEPOSITION. FTN Associates, Little Rock, AR. For primary bibliographic entry see Field 5C. W91-10080

SUPERFUND RECORD OF DECISION: ALAD-

DIN PLATING, PA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10082

SUPERFUND RECORD OF DECISION: CIBA-GEIGY, NJ.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10083

EFFECTS OF AGRICULTURAL PRACTICES ON THE NITRATE CONCENTRATIONS IN THE SURFACE WATER DOMESTIC SUPPLY SOURCES OF WESTERN EUROPE.

G. Roberts, and T. Marsh.

Institute of Hydrology, Wallingford (England).
G. Roberts, and T. Marsh.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 365-380, 8 fig, 20 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Europe, \*Fertilizers, \*Nitrates, \*Nonpoint pollution sources, \*Water supply, European Economic Community, Fate of pollutants, Leaching, Path of

pollutants, Water quality standards, Water quality trends.

During the last thirty years or so, nitrate concentrations in the surface waters of most western European countries have been rising steadily. Al-though these increases can be attributed to many factors, it is generally agreed that the major con-tributor has been the intensification in agricultural practices, particularly the massive increase in the use of inorganic fertilizers, that has been a feature of this period. In some areas, concentrations in surface water domestic supply sources exceed intermittently, or continuously, the World Health Organization limit for nitrate in potable water. Estimating the amount of leaching losses from agricultural land is difficult because of a number of agricultural land is difficult because of a number of factors including soil type, crop grown, rate and timing of fertilizers and climate. Also, predicting future losses is complicated by future plans within the Common Agricultural Policy of the European Economic Community and whether the current overproduction will continue. (See also W91-10103) (Author's abstract) W91-10137

FACTORS GOVERNING MERCURY ACCUMULATION IN THREE SPECIES OF MARINE MACROALGAE.

Universidade Nova de Lisboa (Portugal). Faculdade de Ciencias e Tecnologia.

J. G. Ferreira.

Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 335-343, March 1991. 3 fig, 3 tab, 15 ref.

Descriptors: \*Algal physiology, \*Bioaccumulation, \*Marine pollution, \*Mercury, \*Path of pollutants, \*Seaweeds, \*Trace metals, Chlorophyta, Phaeophyta, Plant physiology, Rhodophyta, Variability, Water pollution effects.

Mercury (Hg) accumulation was studied in Fucus vesiculosus, Ulva lactuca, and Gracilaria verrucosa, sampled in areas of different pollution loads. cosa, sampled in areas of different pollution loads. The Hg concentration in the seaweeds was variable, but interesting trends emerge for the different species. High levels of mercury were observed in Gracilaria verrucosa, which are probably associated with the greater productivity of this species and its longer period of immersion through the tidal cycle. The accumulation factors observed between Hg in algae and in solution are on the order of 10,000 for all studied species. The mean Hg levels in the seaweeds show significant intraspecific variability between sites of different pollution levels, as well as interspecific variability at each site. Microcosm experiments showed a direct relationship becosm experiments showed a direct relationship be-tween dissolved Hg and both the accumulation rate and the Hg concentration in the algae. (Author's abstract) W91-10167

PRELIMINARY INVESTIGATIONS INTO THE BACKGROUND LEVELS OF VARIOUS METALS AND BORON IN THE AQUATIC LIVERWORT SCAPANIA ULIGINOSA (SW.) DUM. Wroclaw Univ. (Poland). Dept. of Ecology and Nature Protection.

A. Samecka-Cymerman, A. J. Kempers, and P. L. E. Bodelier.

Aquatic Botany AQBODS, Vol. 39, No. 3/4, p 345-352, March 1991. 1 fig, 3 tab, 19 ref.

Descriptors: \*Aquatic plants, \*Baseline studies, \*Bioindicators, \*Boron, \*Environmental quality, \*Heavy metals, \*Liverworts, \*Path of pollutants, Belgium, Bryophytes, lon concentration, Poland, Water chemistry, West Germany.

Bryophytes can provide a reliable indication of the occurrence of metal in the environment, because occurrence or mean in the environment, occasions the absence of epidermis and cuticle permits easy penetration and concentration of metal ions, facilitating the integration of temporal fluctuations in water chemistry. Populations of the aquatic liverwort Scapania uliginosa, found in Sudeten streams in Poland and Ardennes streams in Belgium and West Germany, were exposed to various levels of metals and boron concentrations, mainly of natural origin. S. uliginosa contains up to a maximum (in

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mg/kg dry plant weight) 518 B, 418 Ba, 16 Cd, 180 Co, 292 Cu, 11 Li, 10,700 Mn, 243 Ni, 464 Pb, 955 Sr, 123 V, and 2067 Zn. Elevated concentrations of the elements examined were found in S. uliginosa growing in mineralized zones relatively free of human pollution. The highest concentrations are indicative of bryophytes growing in low to moderately contaminated environments. (Brunone-PTT) W91-10168

CHLORIDE AND SULFATE SALINITY EFFECTS ON SELENIUM ACCUMULATION BY TALL FESCUE.

California Univ., Davis. Dept. of Environmental Horticulture.

Hortcuture. L. Wu, and Z. Z. Huang. Crop Science CRPSAY, Vol. 31, No. 1, p 114-118, January/February 1991. 1 fig, 6 tab, 20 ref.

Descriptors: \*Bioaccumulation, \*California, \*Fescues, \*Groundwater pollution, \*Kesterson Wildlife Refuge, \*Path of pollutants, \*Salinity, \*San Joaquin Valley, \*Selenium, \*Soil chemistry, \*Sulfates, Biomass, Plant growth.

The discovery of high levels of Se in soil and water samples from the San Joaquin Valley, California, and of its responsibility for deformity and death of wildlife at Kesterson National Wildlife Refuge have renewed interest in selenium bioaccumulation. Greenhouse nutrient solution culture and field experiments were conducted to examine the effects of Cl and SO4 salt on growth and Se accumulation in tall fescue (Festuca arundinacea) cultivars Alta, Falcon, and Olympic. Sulfate salt substantially reduced growth inhibition and Se accumulation. Tall fescue from the field irrigated with water low in salinity had higher tissue Se concentration than plants from the field irrigated with water high in salinity. No difference in tissue Se concentration than plants from the field irrigated with water high in salinity. No difference in tissue Se concentration was found among the three tall fescue cultivars; however, forage-type Alta produced the most shoot biomass and accumulated the most total Se. The soil irrigated with water high in salinity had ten times higher Se concentration than soil irrigated with water low in salinity. The high-set soil Se concentration was found in the top 15 cm of soil. Growing fescue for one year reduced soil Se by 50%. Selenium concentrations below 15 cm depth were lower and similar between the bare soil and the soil under tall fescue. Both the high and low salinity water irrigations did not cause high levels of Se accumulation in the tall fescue cultivars unless there was continual addition of Se into the system. (Author's abstract)

EFFECT OF SHORE POSITION AND ENVIRONMENTAL METAL LEVELS ON BODY METAL BURDENS IN THE BARNACLE, ELMINIUS MODESTUS.

Manchester Univ. (England). Dept. of Environ-

mental Biology. K. Al-Thaqafi, and K. N. White. Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 89-104, 1991. 6 fig, 1 tab, 32 ref.

Descriptors: \*Barnacles, \*Bioaccumulation, \*Heavy metals, \*Metals, \*Path of pollutants, \*Wales, Anglesey, Calcium, Copper, Iron, Manganese, Menai Strait, Seasonal variation, Water pollution, Zipoc.

Body (thorax and prosoma) weight, shell growth, and Zn, Cu, Fe, Mn and Ca levels were measured in artificially settled Eliminus modestus over a 14-month period following transfer to high, mid and low tide positions in the uncontaminated Menai Strait North Wales and two mid tide sites within a Zn and Cu polluted bay on the North West coast of Anglesey. Barnacles showed higher mortality and slower growth at the upper shore position than at any other site. There was no evidence of Zn and Cu regulation by the bodies or shells, and both seemed to reflect environmental levels. Body metal levels were lowest in early winter and the highest second year values were found in January (Zn), March (Cu, Fe) or May (Ca). Higher shore barnacles contained larger concentrations of Zn than mid or low tide animals. Differences in feeding activity and the amount of testes may account for

these variations. Reciprocal transplants between polluted and clean sites indicate that body Cu and Zn accumulation and loss was very rapid. Spatial and temporal changes in shell metal levels closely mirror that of the body. (Author's abstract)

EXPOSURE TO TRACE ELEMENTS OF FLA-MINGOS LIVING IN A BIOSPHERE RE-SERVE, THE CAMARGUE (FRANCE).

CNRS URA 1356 Ecotoxicologie, Faculte de Pharmacie, 1, rue Gaston Veil, 44035 Nantes Cedex, France.

C. Amiard-Triquet, D. Pain, and H. T. Delves. Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 193-201, 1991. 2 tab, 31 ref.

Descriptors: \*Bioaccumulation, \*France, \*Heavy metals, \*Path of pollutants, \*Trace elements, \*Water birds, Cadmium, Camargue Biosphere Reserve, Copper, Flamingos, Lead, Selenium, Wildlife habitats, Zinc.

Some adult flamingos Phoenicopterus ruber roseus collected from the Camargue Biosphere Reserve had tissue metal concentrations considerably higher than the average for this species. As the range of these birds is large, and the origin of the contamination unknown, blood and feather samples from nestling flamingos were analyzed for trace metals to determine the presence and origin of local contamination. A comparison of elemental concentration in the feathers of nestling and adult birds revealed higher concentrations of Cd, Cu, Pb, and Se in adults, and higher concentrations of Xn in juveniles. This was attributed to increased exposure to atmospheric pollutants of adults, and either differences in Zn requirements and metabolism between adults and juveniles, or a local contamination of the juveniles' food supply by Zn. Concentrations of Zn in serum were also very elevated compared with human standards. Cd, Cu, Zn, and Se were analyzed in outer and inner barbs (i.e. barbs that are, respectively, exposed or not exposed to external deposits) of greater coverts of nestling flamingos. A comparison of elemental concentrations if these two feather components indicates a local atmospheric contamination by Cd, Cu and Pb. (Author's abstract)

DISTRIBUTION OF SELECTED HEAVY METALS IN SKIN AND MUSCLE OF FIVE TROPICAL MARINE FISHES.

University of the West Indies, St. Augustine (Trinidad and Tobago). Dept. of Chemistry.
J. G. Singh, I. Chang-Yen, V. A. Stoute, and L.

Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 203-215, 1991. 2 fig, 9 tab, 17 ref.

Descriptors: \*Bioaccumulation, \*Fish, \*Heavy metals, \*Marine pollution, \*Path of pollutants, \*Sampling, \*Trinidad, Cadmium, Chromium, Copper, Iron, Lead, Marine environment, Monitoring, Nickel, Tissue analysis, Zinc.

The effects of tissue type, tissue location and size of fish on the heavy metal levels of five species of fish (Lutjanus synagris, Micropogon furnieri, Cynoscion leiarchus, Catanx hippos and Scomberomorus brasilienis) found in the marine environment of the tropical island of Trinidad were investigation of the tropical island of Trinidad were investigative after acid digestion of muscle and skin tissues, but only Fe, Zn, and Cu were detected. Skin showed elevated levels of metals compared to muscle, and significant differences in metal levels with respect to tissue location in skin, and varying effects of size on the metal levels in both muscle and skin in different species, were found. These results emphasize the need for careful sampling of tissue in these species for obtaining reliable data on heavy metal levels. It is recommended that, for any detailed survey of metal levels in these species, skin and muscle should be combined and homogenized before subsampling is attempted, and a specific size, or narrow range of the individual species should be selected for heavy metals monitoring. (Sand-PTT)

W91-10208

FATE OF HYDROPHOBIC ORGANIC POL-LUTANTS IN THE AQUATIC ENVIRONMENT: A REVIEW.

Universidad Simon Bolivar, Caracas (Venezuela). Dept. of Chemistry. R. Jaffe.

Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 237-257, 1991. 1 fig, 114 ref.

Descriptors: \*Aquatic environment, \*Biogeochemistry, \*Fate of pollutants, \*Hydrophobic compounds, \*Organic pollutants, \*Path of pollutants, Bioaccumulation, Biodegradation, Dissolved solids, Evaporation, Literature review, Sedimentwater interfaces, Solubilization.

The fate of hydrophobic organic pollutants in the aquatic environment is controlled by a variety of physical, chemical, and biological processes. Some of the most important are physical transport, chemical and biological transformations, and distribution of these compounds between the various environmental compartments (atmosphere, water, sediments, and biota). This review covers the major biogeochemical processes that control the fate of hydrophobic organic compounds in the aquatic environment. These processes include evaporation, solubilization, interaction with dissolved organic matter, sediment-water partitioning, bioaccumulation and degradation. Physicochemical parameters such as the octanol-water partition coefficient (Kow) and the bioconcentration factor (Kbc) can be used to predict the aquatic fate of such compounds. (Author's abstract)

DISTRIBUTION AND FLUXES OF METALS IN THE ST. LAWRENCE RIVER FROM THE OUTFLOW OF LAKE ONTARIO TO QUEBEC CITY.

Direction, Ecotoxicologie et Ecosystemes, Centre St. Laurent, 105 rue McGill, Montreal H2Y 2E7, Quebec, Canada.

K. R. Lum, K. L. E. Kaiser, and C. Jaskot. Aquatic Sciences AQSCEA, Vol. 53, No. 1, p 1-19, 1991. 4 fig, 5 tab, 18 ref.

Descriptors: \*Heavy metals, \*Lake Ontario, \*Metals, \*Path of pollutants, \*St Lawrence River, \*Water pollution sources, Cadmium, Copper, Nickel, Regression analysis, Water sampling, Zinc.

Six anchor stations in the St. Lawrence River from the outflow of Lake Ontario to Quebec City were occupied for about 24 hours in June 1987 during low flow conditions. Samples of water and suspended particulate matter were collected every 2 h and separated by continuous-flow centrifugation. During the sampling period, fluxes of dissolved forms of Zn, Cu and Ni increased in Lac St. Francois and downstream relative to the sum of the fluxes for the two upstream stations at the outflow of Lake Ontario. Increases in the flux of the fluxes for the two upstream stations at the outflow of Lake Ontario. Increases in the flux of dissolved Zn and Ct were pronounced below Montreal and above Lac St. Pierre. For particulate forms of Cd, Pb, Zn, Cu, and Ni, there are significant inputs in the section of the St. Lawrence River between Lac St. Francois and the station just above the entrance to Lac St. Pierre. The average concentrations of dissolved Cd, Pb, Zn, Cu and Ni ranged from 7-23 ng/L, 9-35 ng/L, 0.434-0.939 microgram/L, 0.15-0.89 microgram/L, and 0.58-1.12 microgram/L, respectively. Regression analysis of the dissolved and particulate metal concentration. This prediction of particulate metal concentration. This prediction appears to be independent of the suspended particulate matter concentration which varies from about 1-10 mg/L from the outflow of Lake Ontario to Quebec city. (Author's abstract)

CONCENTRATION AND DISTRIBUTION OF PCB CONGENERS IN ISOLATED ONTARIO

### Group 5B-Sources Of Pollution

LAKES CONTAMINATED BY ATMOSPHERIC DEPOSITION.

Trent Univ., Peterborough (Ontario). Environmen-

Telm Only, Peterborough (Chanto). Environmental and Resource Studies Program.

C. R. Macdonald, and C. D. Metcalfe.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 371-381, March 1991. 4 fig, 3 tab, 28 ref.

Descriptors: \*Air pollution, \*Lake sediments, \*Path of pollutants, \*Polychlorinated biphenyls, \*Suspended solids, \*Water pollution sources, Bioaccumulation, Canada, Dry decomposition, Fish, Lakes, Ontario, Zooplankton.

The concentration of 19 PCB congeners was ana lyzed in biota, sediments, water, and suspended solids in four central Ontario lakes in which atmospheric deposition was the major source of PCB contamination. Input from the atmosphere resulted contamination, input from the amosphere resulted in total concentrations of 1-2 ng/L dissolved in water, 10-50 microgram/kg (dry weight) in sediment, 5-10 microgram/kg (dry weight) in biota from lower trophic levels (i.e. zooplankton, golden shiner (Notemigonus crysoleucas)), and 10-30 microgram/kg (wet weight) in fish from upper trophic levels (yellow perch (Perca flavescens), smallmouth bass (Micropterus dolomieui)). The dominant PCB congeners in the lakes were the trichlorophenyl congeners 31(28) and the hexachlorophenyl congeners 153 and 138, consistent with congener distributions reported for vapor-bound and particulate-bound PCBs in the atmosphere. and particulate-bound PCBs in the atmosphere. Discriminant analysis indicated slight differences in congener patterns between the study lakes, but the general patterns for isolated lakes was substantially different from point-source contaminated lakes, primarily due to the high proportion of congeners 31(28). There was no significant difference in the total PCB concentrations in biota (lipid basis) be-tween lakes, but within the lakes total PCB concentrations were significantly higher in yellow perch than in biota from lower trophic levels. (Author's abstract) W91-10228

# SORPTION STUDIES OF VOCS RELATED TO SOIL/GROUND WATER CONTAMINATION AT LUNL.

AT LLNL.

Lawrence Livermore National Lab., CA.

D. J. Bishop, J. P. Knezovich, and D. W. Rice.

Available from the National Technical Information

Service, Springfield, VA. 22161, as DE89-016698.

Price codes: A03 in paper copy, A01 in microfiche.

Report No. UCID-21651, August 1989. 12p, 4 fig,

7 tab, 28 ref. DOE Contract W-7405-Eng-48.

Descriptors: \*Groundwater pollution, \*Lawrence Descriptors: "Counawater pointion, "Lawrence Livermore National Laboratory, "Path of pollutants, "Sorption, "Volatile organic compounds, Aquifers, Geohydrology, Groundwater movement, Minerals, Permeability, Soil water, Sorptivity, Tetrachloroethylene, Valoes zone.

In 1980, Lawrence Livermore National Laboratory (LLNL) initiated a preliminary groundwater study beneath and in the vicinity of the LLNL site in Livermore, California. Findings from that study indicated that volatile organic compounds (VOCs), primarily tetrachloroethylene (PCE) and trichloroethylene (TCE), were present in local groundwater. In order to predict the rate and extent of movement of the VOCs in groundwater, it is essential to understand the sorptive properties of these compounds in relation to the subsurface soils that exist in this area. TCE and PCE were selected for this purpose initially because of their predomithis purpose initially because of their predomi-nance in the contaminant plume. Additional tests were performed using 1,2-dichloroethane (DCA), 1,2-dichloroethane (DCA), 1,2-dichloroethane (DCE), and chloroform (CF). In general, sorption of the VOCs to LLNL aquifer material is low. PCE, which is the most highly chlorinated and least soluble of the chemicals studied, was sorbed the most. The organic C content of led, was sorbed the most. The organic C content of local subsurface material is very low (usually < 0.2%) and does not appear to correlate with sorption constants of chemicals tested. It appears that mineral surfaces and surface are of the aquifer material may determine the extent of sorption. Formulas available in the literature for predicting sorption constants underestimated measured values

due to the fact that these formulas are nonlinear at these low organic-C values. Calculated retardation values based on partition coefficient data appear to overestimate the actual retardation expected of the VOCs studied. Regions of highly permeable material or fracture flow in the aquifer could account for more rapid transport in some areas. (Lantz-PTT) W91-10235

STATUS REPORT ON REMEDIAL INVESTI-GATION OF THE 300 AREA PROCESS PONDS. GATION OF THE 300 AREA PROCESS PONDS. Battelle Pacific Northwest Labs., Richland, WA. D. I. Dennison, D. R. Sherwood, and J. S. Young. Available from the National Technical Information Service, Springfield, VA. 22161, as DE90-000867. Price codes: A05 in paper copy, A01 in microfiche. Report No. PNL-6442, September 1989. 75p, 14 fig, 10 tab. 5 ref, 2 append. DOE Contract DEACO6-76RLO 1830.

Descriptors: \*Path of pollutants, \*Process ponds, \*Radioactive wastes, \*Sediment contamination, \*Radioactive wastes, \*Sediment contamination, \*Water pollution sources, Aluminum, Cesium ra-dioisotopes, Chromium, Cobalt radioisotopes, Copper, Nickel, Organic compounds, Pollutant identification, Polychlorinated biphenyls, Process water, Radioactivity, Silver, Stabilization ponds, Uranium, Zinc.

A remedial investigation (RI) of the South and North Process Ponds adjacent to the 300 Area at the US Department of Energy (DOE) Hanford Site was initiated in FY 1987 as partial implementation of the DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program. The objective of FY 1987 activities was initial characterization of the quantity and distribution of contaminants in the sedity and distribution of contaminants in the sedi-ments. Sediment samples from 14 locations in and ments. Sediment samples from 14 locations in and adjacent to the ponds were collected and analyzed. Initial results indicated that contaminated sediments in the ponds typically contained high gross alpha and gross beta activities and concentrations of Ag, Al, Cr, Cu, Ni, and Zn that were elevated relative to background levels. Radiochemical analyses of the sediments showed that the primary radiological contaminant was uranium; cobalt-60 and cesium-137 were detected in several samples. Organic compounds, including polychlorinated bi-phenyls (PCBs), were also detected in several sam-ples. Future RI activities will be undertaken under EPA-approved RI/FS work plans. (Author's ab-W91-10237

# HYDROLYSIS RATE CONSTANTS FOR ENHANCING PROPERTY-REACTIVITY RELATIONSHIPS.

Environmental Research Lab., Athens, GA. J. J. Ellington.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-220479. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/3-89/063, July 1989. 50p, 9 fig. 12 tab, 23 ref.

Descriptors: \*Fate of pollutants, \*Hydrolysis, \*Organic compounds, \*Path of pollutants, \*Water chemistry, Aliphatic compounds, Amides, Carbamates, Chemical reactions, Chemical structure, Epoxides, Esters, Ethers, Halides, Halogenated compounds, Infrared spectrophotometry, Nitriles, Sulfur compounds Sulfur compounds.

This report examines the rate constants for hydrolysis in water of 10 classes of organic compounds with the objective of establishing new or expanding existing property-reactivity correlations. These relationships can then be used to predict the environmental hydrolysis fate of chemicals that have romained hydrolysis fate of chemicals that have similar molecular structure. The compound classes covered by this report include: aliphatic and aro-matic carboxylate esters, alkyl and aromatic halides, ambdes, carbamates, epoxides, nitriles, phos-phate esters, alkylating agents, halogenated ethers, and oxidized sulfur compounds. Three predictive techniques (one based on empirical correlations with derived constants, another using infrared spectra, and a third relying on fundamental calculations requiring only chemical structure) were used to predict and compare hydrolysis rate constants for simple alkyl esters. The predicted rate constants were generally within a factor of two of each other and the laboratory-determined values. (Author's abstract) W91-10246

# PRELIMINARY DATA SUMMARY FOR THE TRANSPORTATION EQUIPMENT CLEANING INDUSTRY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.

F. Hund. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126483. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/440/1-89/104, September 1989. 112p, 8 fig, 39 tab. EPA Contract Nos. 68-03-6302 and 68-03-3339.

Descriptors: \*Sewage, \*Tank cleaning, \*Transportation, \*Wastewater treatment, \*Water pollution sources, Effluents, Heavy metals, Public health, Herbicides, Organic compounds, Pesticides, Railroads, Trucks.

The Industrial Technology Division (ITD) of the EPA conducted a preliminary study of the transportation equipment cleaning industry as a result of the evaluation of the findings from the Domestic Sewage Study (DSS). As part of the study, EPA identified approximately 400 tank truck cleaning facilities, 90 rail tank car cleaning facilities, and 200 tank barge cleaning facilities. These are believed to represent nearly complete coverage of for hire facilities in the United States. In addition, the Agency collected samples of raw and treated effluent and sludges at 8 transportation equipment Agency conected samples of raw and treated effluent and sludges at 8 transportation equipment cleaning facilities. A total of 111 'List of Analytes' organic pollutants, 52 of which are priority pollutants, were detected in the samples. All 13 priority pollutant metals were found. Review of environmental interest data in the samples. mental impact data indicates that in many instances mental impact data indicates that in many instances the concentrations of pollutants in raw wastewater from individual facilities within this industry exceed EPA criteria for protection of human health and aquatic life. Raw pollutant loadings per day were: priority organics = 81,000 lbs/day; and, priority inorganics = 30,000 lbs/day. High priority organic pollutant loadings were: acrylonitrile (30,000 lbs/day); acrolein (41,000 lbs/day); and, benzene (2,000 lbs/day). High priority organic pollutant loadings were: arsenic (5,000 lbs/day); and, cyanide (7,000 lbs/day). In an environmental impact analysis, a total of 111 organic pollutants (including pesticides and herbicides) were detected in wastewaters at transportation equipment cleanin wastewaters at transportation equipment cleaning facilities. Of these, 50 are on EPA's Priority Pollutant List, 52 are RCRA Hazardous Constituents, 72 are CERCLA Hazardous Substances, and five are known or suspected human carcinogens. (Lantz-PTT) W91-10253

# DRILLING AND PRODUCTION DISCHARGES AND OIL SPILLS IN THE MARINE ENVIRONMENT.

Minerals Management Service, Vienna, VA. Atlantic OCS Region.

lantic OCS Region the National Technical Information Service, Springfield, VA. 22161, as PB90-10041. Price codes: A04 in paper copy, A01 in microfiche. Report No. OCS EIS/EA, MMS 89-0065, March 1989. 79p, 4 fig, 8 tab, 97 ref, append. Edited by S. Allison Abernathy.

Descriptors: \*Cleanup operations, \*Offshore plat-forms, \*Oil industry, \*Oil pollution, \*Water pollu-tion sources, Booms, Dispersants, Drilling, Drilling fluids, Oil spills, Skimmers.

potential effects of Outer Continental Shelf (OCS) oil and gas operations on the marine envi-ronment have been the subject of much research and public debate. The potential adverse impacts from drilling and production discharges and oil rom drilling and production discharges and on spills on marine ecosystems are important environ-mental issues. Oil industry operations on the OCS typically result in discharge of drilling muds and cuttings as well as small amounts of oil and

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wastewater. The primary bulk components are water, barite, clay minerals, chrome lignosulfate, lignite, and sodium hydroxide. Specialty additives such as bactericides and diesel fuel may be added to control mud properties. The EPA and Marine Management Service (MMS) restrict the discharge of muds containing diesel fuel. Cuttings removed from the drilling mud are usually discharged continuously into the water column by either overboard discharge or shunting through a pipe to some depth. Typically, for an exploratory well in the Atlantic OCS, 5000 to 30000 billion barrels of weith the discharge of well and and 3000 to 6000 billion barrels of wet some depth. 19/caily, for an exploratory well in the Atlantic OCS, 5000 to 30000 billion barrels of drilling mud and 3000 to 6000 billion barrels of west solids (mostly cuttings) are discharged over the lifetime of the well. For a development well, the quantity is generally less. Deck drainage, and domestic and sanitary wastes are also discharged from offshore oil and gas facilities. Oil spills are another major concern of exploration and production of offshore hydrocarbon resources. Historically, major OCS oil spills (> or = 1000 billion barrels) have been the result of pipeline accidents, platform accidents such as well blowouts or fires, and tanker and barge accidents. The effectiveness of oil spill cleanup depends largely on the circumstances characterizing the spill, such as the rate, volume, and type of oil spilled, the weather and sea conditions, and the location. Booms and skimmers are used primarily for large spills while sorbents are useful in small spills. Although oil will disperse naturally as it spreads and weathers, chemical dispersants accelerate the process by reducing the persants accelerate the process by reducing the surface tension between oil and water. Dispersion of the oil enhances weathering processes such as oxidation and biodegradation. Use of dispersants may be considered in the open ocean when condi-tions preclude the use of booms and skimmers, or when an oil slick is threatening areas of biological, culture, histo (Lantz-PTT) W91-10254 historical, or recreational importance.

HEALTH ASSESSMENT FOR: SOUTH ANDO-VER, ANDOVER, MINNESOTA.

Agency for Toxic Substances and Disease Registry, Atlanta, GA.

For primary bibliographic entry see Field 5G. W91-10256

METEOROLOGICAL INFLUENCES ON MOUNTAIN CLOUDWATER CHEMISTRY IN THE EASTERN USA.

Oregon State Univ., Corvallis. Dept. of Atmos-

pheric Sciences R. J. Vong. B J. Vong, B. H. Bailey, M. J. Markus, and V. A.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-132432. Price codes: A02 in paper copy, A01 in microfiche. Text from a Poster Presentation at: International Conference on Forest Decline Research-State of Knowledge and Perspectives, Friedrichshafen, Germany, October 2-6, 1989. Report EPA/600/D-89/263, 1989. 2p, 7 ref.

Descriptors: \*Acid rain, \*Air pollution, \*Atmospheric chemistry, \*Cloud chemistry, \*Cloud liquid water, \*Meteorology, \*Path of pollutants, Alpine regions, Clouds, Model studies, Precipitation, Sta-

To relate cloud water composition with large-scale circulation features, cloud events sampled during the 1986-88 field seasons by the EPA Mountain Cloudwater Chemistry Program (MCCP) were closulvated according to the principal synoptic fea-tures responsible for cloud production. This scheme classifies cloud events according to a mountain's location relative to surface weather map features for hours when cloud was observed at the sites. Goals were to: understand the extreme variability in cloud water chemistry; analyze the effect of the part-time, non-random sampling proeffect of the part-time, non-random sampling pro-tocol (every cloud hour was sampled during sever-al multiple week sampling intensives but no events were sampled for other multiple week periods); and establish meteorological scenarios for cloud water interception models. Statistical models de-scribed significant variation in cloud water concen-trations with synoptic-trajectory class cloud type trations with synoptic-trajectory class, cloud type, and sometimes for different trajectories within a

single synoptic type. Cap clouds and warm sector events were more concentrated (lower pH) than other cloud water events while non-precipitating other cloud water events while non-precipitating clouds were more concentrated than precipitating clouds. Persistence of a meteorological regime tends to prevent obtaining a fully representative sample of the growing season meteorology using a part-time sampling protocol. However, the protocol did not greatly bias the seasonal means because random rather than systematic differences are observed between the sample and estimated (based on synoptic type) population means. (Lantz-PTT) W91-10257

HEALTH ASSESSMENT FOR LAUREL PARK LANDFILL, NAUGATUCK, CONNECTICUT. Agency for Toxic Substances and Disease Regis-try, Atlanta, GA. For primary bibliographic entry see Field 5G. W91-10263

INTRAUTERINE EXPOSURE TO ENVIRON-MENTAL TOXINS: THE SIGNIFICANCE OF SUBTLE BEHAVIORAL EFFECTS. Wayne State Univ., Detroit, MI. For primary bibliographic entry see Field 5C. W91-10264

LONG-TERM EFFECTS OF SEWAGE SLUDGE AND FARM SLURRIES APPLICATIONS. For primary bibliographic entry see Field 5E. W91-10270

CHEMICAL METHODS FOR ASSESSING BIO-AVAILABLE METALS IN SLUDGES AND SOILS.

SOILS.

Proceedings of a seminar organized by the Commission of the European Communities, Directorate-General Science, Research, and Development, Environment Research Program, held in Muenster, Germany, 11-13 April 1984. Elsevier Science Publishing Co., New York. 1985. 96p.

Descriptors: \*Analytical methods, \*Bioavailability, "Chemical analysis, "Heavy metals, "Land disposal, "Path of pollutants, "Pollutant identification, "Sediments, "Soil contamination, Adsorption, Bioaccumulation, Cadmium, Copper, Leaching, Lead, Nickel, Sludge disposal, Soil analysis, Zinc.

The proceedings of a seminar held at Muenster in the Federal Republic of Germany on April 11-13, 1984 under the auspices of the European Economic Community (EC) review new developments in chemical methods for assessing bioavailability of metals in sludge-treated soils. Utilization of sewage sludge on agricultural land is an essential disposal account and the federal treatment of the federal control of the fede route accounting for about 30% of the 6 million tons (dry solids) of the sewage sludge produced annually in the EC countries. It is essential that tons (dry solids) of the sewage sludge produced annually in the EC countries. It is essential that metal concentrations in sludge-treated soils are not allowed to reach levels which could deleteriously affect soil fertility or animal and human food chains. Recent advances in analytical techniques and a better understanding of soil chemistry have led to the development of more promising chemical methods for assessing the bioavailability of metals in sludge-treated soils. The papers presented deal with a variety of new methods ranging from the use of soil solution and single-step neutral salt extractants to more complex multiple-step procedures. The papers emphasize the extractability of metals (principally cadmium, copper, nickel, zinc, and lead) by the chosen procedures in relation to soil (and in one case sediment) chemistry and bioavailability to crop plants. Specific topics covered are: chemical forms and reactivities of metals in sediments; principles of investigations on the moare: chemical forms and reactivities on metals in sediments; principles of investigations on the mobility and plant uptake of heavy metals; reasons to use neutral salt solutions to assess the metal impact on plant and soils; evaluation of chemical methods for assessing the Cd and Zn availability from different soils and sources; the effect of incubation on ferent soils and sources; the effect of incubation on the term sours and sources; the effect of incubation on the composition of soil solution displaced from four soils treated with zinc, copper or nickel-loaded sewage sludge; and factors influencing heavy metals availability in field experiments with sewage sludges. (See W91-10292 thru W91-10297) (Geiger-PTT)

W91-10291

CHEMICAL FORMS AND REACTIVITIES OF METALS IN SEDIMENTS.

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik. U. Foerstner.

IN: Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Science Pub-lishing Co., New York. 1985. p 1-31. 9 fig, 6 tab, 123 ref.

Descriptors: \*Adsorption, \*Analytical methods, \*Chemical analysis, \*Heavy metals, \*Path of pollutants, \*Pollutant identification, \*Sediment analysis, \*Sediment chemistry, \*Sediments, \*Sorption, Detritus, Extraction, Leaching, Organic matter, Oxides, Particle size, Separation techniques, Suspended sediments. pended sediments

Sediment analyses are used to pin-point major sources of pollutants and to estimate the toxicity potential of dredged materials on agricultural land. For source assessment, standardization is needed with respect to grain size effects. Various methods may be used including extrapolation techniques, mineral corrections, mechanical fractionation, chemical extraction of mobile fractions of metals, and comparison with conservative elements. Only and comparison with conservative elements. Only part of the metals present in sediments or sludges are involved in short-term geochemical proces and/or are bioavailable. Hydrous Fe-and oxides as well as organic matter, partly as coatings or films on detrital grains, are important substrates for the interactions with dissolved metal species in aquatic systems. Sequential extraction procedures were used for the differentiation of the relative bonding strength of metals on various solid phases and for the estimation of their potential reactivity under variable environmental conditions. While these determinations seem to pose basically operational problems, the correlation of the data from solid speciation with the processes and extent of the biological uptake is still unsatisfactory. This is mainly due to the competition between sorption sites on solid matter and biological processes for dissolved metals. A uniform assessment scheme for the bioavailability cannot be established on the basis of extraction chemical data from sediment samples. (See also W91-10291) (Author's abstract) W91-10292

# PRINCIPLES OF INVESTIGATIONS ON THE MOBILITY AND PLANT UPTAKE OF HEAVY

Ghent Rijksuniversiteit (Belgium).

L. Kiekens, and A. Cottenie.

IN: Chemical Methods for Assessing Bio-Available
Metals in Sludges and Soils. Elsevier Science Publishing Co., New York. 1985. p 32-41. 5 fig, 1 tab, 9

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Hydrogen ion concentration, \*Path of pollutants, \*Plant physiology, \*Soil contamination, Cadmium, Copper, Grain crops, Nickel, Soil properties, Zinc.

The study of the mobility of heavy metals in soils takes into account the nature of the element and the effect of soil properties in the determination of the amounts of heavy metals solubilized at differthe amounts of heavy metals solubilized at different pH values. Very significant relationships have been observed between metal concentrations in ryegrass and the amounts of Zn, Cu, Cd and Ni mobilized at different pH values. For the experimental determination of the mobilization pattern, extraction at four pH steps is required: original pH of the soil-water suspension, pH 4.0, pH 2.0, and pH 0.5. Besides the nature of the element, the abovice of the soil also effect. pH 0.5. Besides the nature of the element, the physico-chemical properties of the soil also affect the mobilization pattern. The proposed mobility test allows differentiation between soils with normal and increased levels of heavy metals. The normal and increased levels of neavy metas. Ine effect of the mobility of Zn, Cu, Cd, and Ni in the soil on plant uptake were presented at the third International Symposium on Processing and Use of Sewage Sludge. Equilibration and pot experiments were conducted using two different soils, a sandy and a heavy clay soil, amended with four levels of Zn, Cu, Ni, and Cd. Heavy metals were added in

# Group 5B-Sources Of Pollution

two forms, namely as sulfate salts and incorporated in sewage sludge. After an equilibration period of six months, mobility of heavy metals in all treated soils was determined. Pot experiments were also conducted in the greenhouse with Italian ryegrass. conducted in the greenhouse with Italian ryegrass. The amounts of heavy metals solubilized as a function of pH showed a systematic difference between the salt and sludge addition form, and also between both soils. For Zn, Cd and Ni the sequence of decreasing mobility was: sandy soil, salt form > sandy soil, sludge form = clay soil, salt form > clay soil, sludge. The mobility curves of Cu in both soils and for both forms showed very little differences. These mobility patterns corresponded well with the untake of heavy metals by reverass. Metal with the uptake of heavy metals by ryegrass. Metal uptake followed the same sequence as the mobility of heavy metals in both soils. For the same soil and for the same metal form, plant uptake decreased in the following order: Ni > Cd = Zn > Cu. For both soils very significant correlations of plant concentrations with the amounts of heavy metals Solubilized at different pH values were obtained. (See also W91-10291) (Geiger-PTT) W91-10293

REASONS TO USE NEUTRAL SALT SOLU-TIONS TO ASSESS THE METAL IMPACT ON PLANT AND SOILS.

H. Haini, and S. Gupta. IN: Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Science Pub-lishing Co., New York. 1985. p 42-48.3 fig, 4 tab, 6

Descriptors: \*Analytical methods, \*Bioaccumula-tion, \*Heavy metals, \*Path of pollutants, \*Plants, \*Pollutant identification, \*Soil contamination, Bioavailability, Cadmium, Copper, Hydrogen ion concentration, Soil bacteria, Zinc.

For heavy metal-contaminated soils, it is best to use neutral salt solutions when determining metal fractions which may be available for uptake by plants. The metal content solubilized by a neutral plants. The metal content solubilized by a neutral salt solution is correlated with pH, cation exchange and total metal content of soil. Almost uniform soil contents (soluble in 0.1 M NaNO3) are found independently of soil properties to give defined biological effects. These values for Zn, Cd, and Cu are 1, 0.6, and 1.5 ppm, respectively. The amounts extracted from soils by neutral salt solutions correspond fairly well to the amounts taken up by plants. At soil pH values lower than 6, Cd and Zn are predominantly bound unspecifically. Extracare predominantly bound unspecifically. Extractants with pH values lower than 6 are, therefore of little use to assess the bioavailability of metals in soils. These principles also apply to the bioavailability and uptake of heavy metals by soil microorga-nisms. (See also W91-10291) (Geiger-PTT) W91-10294

EVALUATION OF CHEMICAL METHODS FOR ASSESSING THE CD AND ZN AVAIL-ABILITY FROM DIFFERENT SOILS AND SOURCES.

Bundesforschungsanstalt fuer Landwirtschaft, Brunswick (Germany, F.R.). Inst. fuer Pflanzener-naehrung und Bodenkunde. D. R. Sauerbeck, and P. Styperek.

DN: Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Science Publishing Co., New York. 1985. p 49-67. 11 fig, 10 tab, 40 ref.

Descriptors: \*Analytical methods, \*Bioaccumula-tion, \*Bioavailability, \*Cadmium, \*Chemical anal-ysis, \*Path of pollutants, \*Plant physiology, \*Soil contamination, \*Zinc, Calcium chloride, Heavy metals, Hydrogen ion concentration, Soil proper-ties Soil types. ties, Soil types

The uptake of Cd and Zn by plants was compared from different soils and sources under both pot and field conditions with total and soluble contents of Cd and Zn in soils. Extractants with strong solubi-lization capacities and total contents did not, or not astisfactority, indicate the experimentally found differences in availability of the metals. Neutral salt solutions like 0.1 M NaNO3 and 0.05 or 0.1 M CaCI2, on the other hand, both reflected the actual availabilities reasonably well. The extraction with

NaNO3, however, dissolved very little Cd from NaNOS, nowever, dissolved very little Cd from neutral soils, so that contamination degrees below 2-4 ppm total Cd were hardly detectable. In contrast to this, the extraction with CaCl2 turned out to be a successful tool, which did not only reflect the soil type dependent differences in availability but even the modifying influence of the particular source and the soil pH. A remarkably close correlation between plant uptake and CaCl2 extractability has been ascertained at least for such plants and plant parts which absorbed significant trace and plant parts which absorbed significant trace element quantities. Hence, CaCl2 seems a promis-ing extractant in order to predict the actual Cd and Zn availability from different soils. (See also W91-10291) (Author's abstract)

EFFECT OF INCUBATION ON THE COMPOSITION OF SOIL SOLUTION DISPLACED FROM 4 SOILS TREATED WITH ZINC, COPPER OR NICKEL-LOADED SEWAGE Rothamsted Experimental Station, Harpenden

. M. Adams, and J. R. Sanders.

IN: Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Science Publishing Co., New York. 1985. p 68-81. 7 tab, 7 ref.

Descriptors: \*Copper, \*Incubation, \*Nickel, \*Path of pollutants, \*Sludge disposal, \*Soil contamination, \*Soil solution, \*Zinc, Bioaccumulation, Bioacumulation, Clay loam, Hydrogen ion concentration, Land application, Loam, Silty soils, Soil

Soil solution was displaced from a calcareous silt, a clay loam and two sandy loam soils incubated for 1, 3, 7, 11, 16 and 21 months after metal-loaded sewage sludges had been applied. The soluble organic C contents decreased markedly over the first 3 months, then stabilized, and were similar in all soils after 11 months. The pH values of soil solution from all sludge-treated soils decreased to some tion from all sludge-treated soils decreased to some extent over 7 months, thereafter values from 2 soils stabilized at about pH 7.5 and the other two decreased to about 6.0. The soil solution concentration of zinc, copper and nickel was affected by the total metal added to the soil, by the pH of the soil solution, and by soil properties, such as texture, mineralogy, and content of organic matter and free oxides of Fe, Al and Mn. The pH values of soil cores taken from register pots and their DTPA. cores taken from replicate pots and their DTPA-extractable metal values did not generally show such consistent trends with time as the soil solution concentrations did. When soil solution concentra-tions, DTPA-extractable metal, and total metal tions, DTPA-extractable metal, and total metal content of soil were compared as indices of metal availability to clover plants, all 3 methods were equally good for a single soil, but when data from all 4 soils were used, soil solution was the best index, e.g. for zinc in all 4 soils r=0.92 for solution, 0.54 for DTPA-extractable, and 0.41 for total metal content. (See also W91-10291) (Author's abstract) stract) W91-10296

FACTORS INFLUENCING HEAVY METAL AVAILABILITY IN FIELD EXPERIMENTS WITH SEWAGE SLUDGES, Station d'Agronomie, INRA, Domaine de la Grande-Ferrade, 33140 Pont-de-la-Maye, France. C. Juste, and P. Solda.

C. Juste, and r. Jodda. IN: Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Science Pub-lishing Co., New York. 1985. p 82-88. 5 tab, 1 ref.

Descriptors: \*Bioaccumulation, \*Bioavailability, \*Heavy metals, \*Path of pollutants, \*Sludge disposal, \*Soil contamination, Cadmium, Corn, Crop production, France, Land application, Lettuce, Manganese, Nickel, Soil properties, Vegetation effects

Two long term field experiments were initiated in 1974 and 1976 in the same sandy soil located near Bordeaux, France to measure the effects of heavy sewage sludge applications on the yield and the major and minor element content of a continuous maize crop. In the experiment initiated in 1974, the applied sludge was a liquid anaerobically digested

sludge with a low level of heavy metals. In the experiment initiated in 1976, the applied sludge was a solid anaerobically digested sludge with a high level of heavy metals (Cd and Ni) arising from a battery factory. The metal content in the younger plants was always more important than in the older plants. The decrease of the heavy metal concentration in the older plant tissues was prob ably caused by the root colonization of the poorly metal enriched subsoil. In 1980, lower soil tem-peratures caused increased Ni concentrations in maize leaves and stunted plant growth. In the same year, lower soil temperatures caused decreased Cd year, lower soil temperatures caused decreased Cd uptake by maize. In the maize growing on the soil treated with liquid anaerobically digested sludge, the Mn content was higher than the Mn content of the maize growing in the control plots. However, application of solid anaerobically digested sludge produced maize crops with Mn levels below that of control plots. When a letture grow was cultivest. of control plots. When a lettuce crop was cultivated on the field receiving highly metal polluted sewage sludge, a higher Cd accumulation was observed in maize leaves than in lettuce leaves, whereas nickel was preferentially concentrated in lettuce. (See also W91-10291) (Geiger-PTT) W91-10297

AQUATIC CHEMICAL KINETICS: REACTION RATES OF WATERS. PROCESSES IN NATURAL

For primary bibliographic entry see Field 2K. W91-10309

KINETICS OF CHEMICAL TRANSFORMA-TIONS IN THE ENVIRONMENT.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. For primary bibliographic entry see Field 2K. W91-10310

FORMULATION AND CALIBRATION OF EN-VIRONMENTAL REACTION KINETICS; OXI-DATIONS BY AQUEOUS PHOTOOXIDANTS AS AN EXAMPLE.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-For primary bibliographic entry see Field 2K. W91-10311

CATALYSIS IN AQUATIC ENVIRONMENTS. California Inst. of Tech., Pasadena. Dept. of Envi-ronmental Engineering Science. For primary bibliographic entry see Field 2K. W91-10312

PRINCIPLES OF LINEAR FREE-ENERGY AND STRUCTURE-ACTIVITY RELATIONSHIPS AND THEIR APPLICATIONS TO THE FATE OF CHEMICALS IN AQUATIC SYS-

Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 2K.
W91-10313

KINETICS OF TRACE METAL COMPLEXA-TION: IMPLICATIONS FOR METAL REAC-TIVITY IN NATURAL WATERS.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland). For primary bibliographic entry see Field 2K. W91-10314

CHEMICAL TRANSFORMATIONS OF ORGANIC POLLUTANTS IN THE AQUATIC EN-VIRONMENT.

sische Technische Hochschule, Zurich (Switzerland).

R. P. Schwarzenbach, and P. M. Gschwene IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 199-233. 9 fig, 7 tab, 45 ref.

# WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Sources Of Pollution—Group 5B

Descriptors: \*Chemical degradation, \*Environmental chemistry, \*Fate of pollutants, \*Hydrolysis, \*Kinetics, \*Organic pollutants, \*Oxidation, \*Water chemistry, Aromatic compounds, Biodegradation, Chemical reactions, Inorganic compounds, Oxidation, Oxidation, \*Chemical reactions, Inorganic compounds, Oxidation, \*Chemical reactions, Inorganic compounds, Oxidations, \*Chemical Reactions, \*Inorganic Compounds, Oxidations, \*Chemical Reactions, \*Inorganic Compounds, Oxidations, \*Chemical Reactions, \*Inorganic Compounds, \*Chemical Reactions, \*Chemical Reactions, \*Inorganic Compounds, \*Chemical Reactions, \*Chemical Reacti tion-reduction potential.

Examples of the major chemical transformation examples of the major chemical transformation reactions of organic pollutants in the aquatic environment are given along with the pertinent compound properties and environmental factors that determine the kinetics of such reactions. Hydrolysis reactions occur when a nucleophilic species is attracted by the electron-deficient atom of the bond, or an electrophilic species is attracted by the electron-rich atom of the covalent polar bond in an organic molecule. The most common case of nucleophilic substitution reactions involving organic pollutants is nucleophilic substitution at a saturated carbon atom. A variety of carboxylic and carbonic acid derivatives may undergo hydrolysis. The hy-drolysis rate of carboxylic acid esters is pH-de-pendent over the ambient pH range. In contrast to pendent over the amoient pH range. In contrast to acid-catalyzed hydrolysis, the rate of neutral and base-catalyzed hydrolysis is strongly dependent on both the structure of the acid and the alcohol moiety. Thermodynamic conditions are very help-ful in evaluating the redox conditions under which a given organic pollutant might undergo an oxidation or reduction reaction. In most cases, oxidative or reductive transformation of an organic pollutant requires at least two electrons to be transferred from or to the compound to yield a stable product. Besides molecular oxygen, iron(III) and manganese (III/IV) oxides are the most abundant natural oxidants that may undergo chemical reactions with organic pollutants but also only with very easily oxidizable compounds. In reduction reactions involving polyhalogenated ethanes in an anaerobic sediment-water mixture, the vicinal dehalogenation reaction was found to be most important. Quinoid-type compounds may mediate reductions of organic pollutants in aqueous solution. It is difficult to predict the absolute rate at which a given pollutant will be reduced or oxidized in the environment due to the presence of many potential redox mediators, and the effects of biodegradation by microorganisms. (See also W91-10309) (Geiger-PTT) W91-10316

ROLE OF EXTRACELLULAR ENZYMATIC REACTIONS IN NATURAL WATERS. Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. for Water Resources and Hydrodyn-

For primary bibliographic entry see Field 2K. W91-10317

AB INITIO QUANTUM-MECHANICAL CAL-CULATIONS OF SURFACE REACTIONS: A

Yale Univ., New Haven, CT. Kline Geology Lab. For primary bibliographic entry see Field 2K. W91-10318

ADSORPTION KINETICS OF THE COMPLEX MIXTURE OF ORGANIC SOLUTES AT MODEL AND NATURAL PHASE BOUND-

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research. For primary bibliographic entry see Field 2K. W91-10319

REDOX REACTIONS OF METAL IONS AT MINERAL SURFACES.
Eidgenoessische Technische Hochschule, Zurich

(Switzerland). For primary bibliographic entry see Field 2K. W91-10320

KINETICS OF COLLOID CHEMICAL PROC-ESSES IN AQUATIC SYSTEMS.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. For primary bibliographic entry see Field 2K. W91-10325

TRANSFORMATION OF SEWAGE SLUDGE IN LANDFILLS.

Edigenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

For primary bibliographic entry see Field 5E. W91-10334

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION: EMERGING MANAGEMENT AND POLICY.

For primary bibliographic entry see Field 5G. W91-10388

AGRICHEMICALS AND GROUNDWATER: WHAT DO WE KNOW.

Congressional Research Service, Washington, DC. For primary bibliographic entry see Field 5G.

FACING THE DILEMMA: WHERE DO WE GO FROM HERE.

Iowa Dept. of Natural Resources, Des Moines. For primary bibliographic entry see Field 5G. W91-10391

AGRICULTURE, THE ENVIRONMENT, AND LEACHING.

For primary bibliographic entry see Field 5G. W91-10392

ROLE OF MODELING IN DEVELOPING COST-EFFECTIVE AND ENVIRONMENTALLY SAFE PEST MANAGEMENT PROGRAMS. Cornell Univ., Ithaca, NY. Dept. of Environmen-

tal Engineering.
For primary bibliographic entry see Field 5G.
W91-10393

POLLUTION: CAUSES, EFFECTS AND CON-TROL.
Royal Society of Chemistry, Cambridge, England.
1990. 393p. Edited by Roy Michael Harrison.

Descriptors: \*Path of pollutants, \*Reviews, \*Water pollution control, \*Water pollution effects, \*Water pollution success, Air pollution, Legal aspects, Model studies, Radioactive wastes, Toxic

istes, Wastewater treatment.

An overview of the important concepts of the field of pollution is presented. Although encyclopedic coverage is impossible, the contributions combine to give a broad overview, touching on most of the important areas including radioactive pollution. The material has been updated since the first edition was written (1982), and changes in emphasis, reflecting current perceptions of a fast moving field have been incorporated. Topics covered include: chemical pollution of the aquatic environment; sewage and sewage treatment; toxic waste treatment; health aspects of water quality; air pollutants; chemistry of the troposphere; dispersal and modeling of pollutants; effects of gaseous pollutants on crops and trees; legal aspects; industrial controls; and quantiative systems methods for evaluating pollution. (See W91-10407 thru W91-10422) (White-Reimer-PTT) to give a broad overview, touching on most of the W91-10406

CHEMICAL POLLUTION OF THE AQUATIC ENVIRONMENT BY PRIORITY POLLUTANTS AND ITS CONTROL.

Water Research Centre, Medmenham (England). Medmenham Lab.

B. Crathorne, and A. J. Dobbs.

IN: Pollution: Causes, Effects and Control. Royal
Society of Chemistry, Cambridge, England. 1990.
p. 1-18, 7 tab.

Descriptors: \*England, \*Pesticides, \*Pollutant identification, \*Priority pollutants, \*Water pollution sources, \*Water quality standards, Acidity, Atrazine, Environmental monitoring, Monitoring, Nitrates, Organotin compounds, Regulations.

Specific 'priority' chemicals as pollutants in the aquatic environment in England were assessed. The Directive on pollution selected chemicals to be placed on List I, the 'black' list or List II, the per placed on List I, the black list of List II, the gray' list. Those chemicals on List I have specific limit values. List II contains substances belonging to the families and groups of substances on List I for which limit values have not been determined and substances that are deleterious to the aquatic environment, but are confined to a specific area. Pollution from diffuse sources is more difficult to control than that from point sources. The major control than that from point sources. The major sources of acidity, nitrates, and pesticides are of a diffuse nature. A summary of information on priority pollutants is presented to illustrate the types of chemicals involved and the analytical techniques used to solve the problems that monitoring problems pose. In general, priority pollutants have little in common in terms of use, properties, or behavior. Specific chemicals discussed include atrazine, azin-phosmethyl, 1,2-dichloroethane, endosulfan, and ributyllin oxife. It must be recognized that a new phosmethyl, 1,2-dichioroethane, endosuitan, and tributyltin oxide. It must be recognized that a new chemical, no matter how carefully it is controlled, will eventually become quite widely dispersed in the environment. This is a natural consequence of the second law of thermodynamics which ensures that eventually traces of these chemicals may be found in any environmental example taken recovidfound in any environmental sample taken, provided the analytical detection limit is low enough. (See also W91-10406) (White-Reimer-PTT) W91-10407

CHEMISTRY OF METAL POLLUTANTS IN WATER.

Plymouth Marine Lab. (England).

D. R. Turner.

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 19-32, 3 fig, 2 tab.

Descriptors: \*Chemical properties, \*England, \*Environmental chemistry, \*Heavy metals, \*Path of pollutants, \*Water chemistry, Copper, Model studies, Monitoring, Organic matter, Plutonium, Thermodynamics.

The chemistry of pollutant metals and its consequences for their dispersal and biological effects were reviewed emphasizing general principles. Copper and plutonium are two widely studied elements with very different chemistries and very different sources. Copper is a micronutrient ele-ment which becomes toxic at elevated concentrarions, and which is in widespread industrial use. Plutonium, in contrast, is a synthetic element whose presence in natural waters arises from civil and military uses of nuclear technology. Its chemistry is extremely complex, with four oxidation states possible in aqueous solution, but modeling this chemistry is becoming increasingly urgent in connection with the assessment of radioactive waste disposal options. In addition, natural waters waste disposal options. In addition, natural waters are extremely complex chemical environments. Not only do they contain almost every element in the periodic table, but also dissolved organic matter, and colloidal and particulate material, both inanimate and living. The problem of chemical speciation can be approached in two ways: by chemical modeling and by direct measurement on natural waters. The accuracy of these models is denended to cut (1) identification and correct page. dependent on: (1) identification and correct para-meterization of all relevant processes; (2) the accu-racy of the parameters and input data used; and (3) the correctness of the equilibrium assessment. Direct measurements on natural waters and related model systems therefore provide a complementary approach to modeling which (1) allows the ther-modynamic models to be further developed and refined; (2) allows non-equilibrium behavior to be identified; and (3) provides data which can be used for empirical state-of-the-art modeling in areas where detailed chemical models are not yet available. (See also W91-10406) (White-Reimer-PTT) W91-10408

IMPORTANT AIR POLLUTANTS AND THEIR CHEMICAL ANALYSIS.

Essex Univ., Colchester (England). Inst. of Aero-R. M. Harrison.

# Group 5B-Sources Of Pollution

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 127-155, 14 fig, 14 tab, append.

Descriptors: \*Acid rain, \*Air pollution, \*Air pollution sources, \*Atmospheric chemistry, \*Dry deposition, \*Wet deposition, Carbon dioxide, Carbon monoxide, Hydrocarbons, Nitrogen oxides, Ozone, Particulate matter, Sulfur dioxide.

Most pollutants have both natural and man made sources; although the natural source is often of sizeable magnitude in global terms, on a local scale in populated areas man-made pollutant sources are usually predominant. Pollution sink processes include both dry and wet mechanisms. Dry deposi-tion involves the transfer and removal of gases and particles at land and sea surfaces without the inter-vention of rain or snow. Wet deposition describes scavenging by precipitation (rain, snow, hail, etc.) and is made up of two components, rainout which describes incorporation within the cloud layer, and washout describing scavenging by falling rain-drops. Specific air pollutants include: sulfur dioxide, from the combustion of fossil fuels containing sulfur; suspended particulate matter; oxides of nitrogen, formed by natural microbiological process-es in the soil; carbon monoxide, associated with gasoline-engined vehicles; hydrocarbons, from the evaporation of solvents and fuels, and the partial istion of fuels; carbon dioxide; and secondary combustion of theis; carbon induce; and secondary pollutants such as ozone and aeroxyacetyl nitrate. Recently, the importance of indoor pollutants has also been recognized. Pollutants with indoor sources may build up to appreciable levels because of the slowness of air exchange. (See also W91-10406) (White, Beiner, PTT). 10406) (White-Reimer-PTT) W91-10413

#### CHEMISTRY OF THE TROPOSPHERE.

Essex Univ., Colchester (England). Inst. of Aerosol Science

R. M. Harrison.

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 157-179, 10 fig, 5 tab.

Descriptors: \*Acid rain, \*Air pollution, \*Atmospheric chemistry, \*Path of pollutants, \*Troposphere, \*United Kingdom, Hydrogen ion concentration, Hydrogen peroxide, Hydroxyl radical, Nitric acid, Ozone, Sulfuric acid.

The lowest part of the atmosphere, typically about The lowest part of the atmosphere, typically about 12 km in depth, is termed the troposphere and is characterized by a general diminution of temperature with height. Historically troposphere chemistry considered the cycle of one substance in isolation from those of others. It is now recognized that many of the important atmospheric chemical many of the inportant annospheric chemical cycles are closely inter-linked and that a more integrated approach is appropriate. Recently the hydroxyl radical has been recognized as having an immensely important role. It is responsible for the breakdown of many atmospheric pollutants, while its formation is dependent on others. A review of tropospheric concentrations of the hydroxyl radi-cal found considerable variations in concentrations cal found considerable variations in concentrations estimated by direct spectroscopic measurement, indirect measurement, and modeling. There are also genuine variations with latitude, season, and the presence of atmospheric pollutants. The hydroxyl radical plays a central role, via the peroxy radicals with which it is intimately related, in the production of ozone and hydrogen peroxide. It also continues directly to formation of sufficient and nitric tributes directly to formation of sulfuric and nitric acids, in the atmosphere, as well as indirectly conactus, in the autospiere, as were as indicety con-tributing via ozone and hydrogen peroxide. Thus, atmospheric processes leading to ozone formation will also tend to favor the production of other secondary pollutants, including the strong acids HNO3 and H2SO4. The regional distribution of rainwater pH over the United Kingdom indicates a trend of increasing acidity from west to east. This trend of increasing acidity from west to east. This pattern is due to the prevailing southwesterly circulation bringing relatively clean air into the west of the country. (See also W91-10406) (White-Reimer-PTT) ATMOSPHERIC DISPERSAL OF POLLUT-ANTS AND THE MODELLING OF AIR POL-LUTION.

Warren Spring Lab., Stevenage (England). M. L. Williams.

M. L. Williams. In: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 201-219, 7 fig, 4 tab.

Descriptors: \*Acid rain, \*Air pollution, \*Atmospheric circulation, \*Deposition, \*Model studies, \*Path of pollutants, \*Pollutant transport, Emission control, Mathematical models, Mixing, Sulfur dioxide, Turbulence.

There is frequently the need for detailed knowledge on the characteristics and quantities of pollut-ants emitted to the atmosphere and on the atmospheric processes which govern their subsequent dispersal and fate. A wide variety of techniques are available, ranging from the most simple box' model through to numerical solutions of the basic equations of fluid flow. When determining dispersion and transport in the atmosphere aspects that must be determined are: (1) mechanical turbulence; must be determined are: (1) mechanical turbulence; (2) turbulence and atmospheric stability; (3) mixing heights; (4) building and topographical effects; and (5) removal processes (wet and dry deposition). Modeling of air pollution dispersion requires consideration of near field dynamics; emission inventories; and long range transport. In general, long term average concentrations can be predicted with greater confidence than short term averages. In urban areas where there are usually numerous sources from all wind directions around receptors, annual average concentrations of relatively inert pollutants, such as SO2, can generally be predicted to better than a factor of two accuracy on most occasions. In the context of the evaluation of air pollution control strategies it should be noted that the Gaussian plume model and the behavior of the primary pollutants to which it is usually applied are linear in emission rates so that such models will predict concentration reductions proportional to emission reductions which might arise from any postulated control technology. (See also W91-10406) (White-Reimer-PTT)

# ORGANOMETALLIC COMPOUNDS IN THE ENVIRONMENT. Leicester Polytechnic (England). School of Chem-

istry.
J. R. Ashby, and P. J. Craig.
IN: Pollution: Causes, Effects and Control. Royal
Society of Chemistry, Cambridge, England. 1990.
p 309-342, 1 fig, 7 tab.

Descriptors: \*Environmental chemistry, \*Organometals, \*Path of pollutants, \*Pollutant identification, \*Toxic wastes, \*Toxicity, Antifoulants, Biocides, Leaching, Organolead compounds, Organomercury compounds, Organotin compounds.

Organometallic compounds usually enter the envi-ronment following use as commodities, although there are instances of the formation of these com-pounds in the environment (e.g., mercury methylapounds in the environment (e.g., mercury mentyla-tion). Some organometallic products are applied directly to the environment as biocides, in anti-fouling paints, or in fossil fuels. Others reach the wider environment indirectly (e.g., leaching from organotin-based PVC stabilizers). In general it is necessary to consider not only the direct toxicity of the compound but the toxicities of possible of the compound but the toxicities of possible metabolites at points other than those of initial application. Formation of organometallic comnds in the environment is important because the organic derivatives usually are of greater toxicthe organic derivatives usually are of generic toxic-tity than their parent inorganic metals or ions. Hence the complete cycling or transport of the original organometallic compound in the environ-ment must be considered. An overview of organometallics in the environment was conducted that covers organotin, organolead, organomercury, and other organometallic compounds in regard to use and toxicity, detection and transformation. (See also W91-10406) (White-Reimer-PTT)

#### RADIOACTIVITY IN THE ENVIRONMENT.

Lancaster Univ. (England). Inst. of Environmental and Biological Sciences C. N. Hewitt.

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 343-366, 5 tab, 7 ref.

Descriptors: \*Ecological effects, \*Path of pollutants, \*Radiation, \*Radioactivity assets, \*Radioactivity, \*Risks, Background radiation, Nuclear accidents, Nuclear energy, Nuclear powerplants, Radioactivity effects, Radionuclides.

Pollution of the natural environment by radioactive substances is of concern because of the considerable potential that ionizing radiation has for damaging biological material. Although both the benefits of controlled exposure for medical purposes and the catastrophic effects of large doses of radiation are well understood, what is less clear are the effects of small doses on the general population. In order to determine these effects an understanding is required of the actual and potential source strengths, the pathways and cycling of radioactivstrengths, the pathways and cycling of radioactivity through the environment and their flux rates, and the possible routes of exposure for man. An overview is presented of radiation and radioactivity including types of radiation, energy changes of nuclear reaction, rates of radioactive decay, radioactive decay series, production of artificial radion-uclides, nuclear fission, beta decay of fission products, and units of radiation dose. Other topics ucts, and units of radiation dose. Other topics reviewed include: (1) biological effects of radiation; (2) natural radioactivity; (3) medical applications of radioactivity; (4) pollution from nuclear weapons explosions; (5) pollution from electric power generation plant and other nuclear reactors; and (6) pollution from non-nuclear processes. (See also W91-10406) (White-Reimer-PTT) W91-10421

# QUANTITATIVE SYSTEMS METHODS IN THE EVALUATION OF ENVIRONMENTAL POLLUTION PROBLEMS.

Lancaster Univ. (England). Centre for Research on Environmental Systems.

In: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 367-388, 7 fig, 1 tab, 5 ref.

Descriptors: \*Environmental monitoring, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Systems analysis, \*Water pollution effects, Data processing, Data requirements, Environmental management, Forecasting, Time series analysis.

One of the first steps in the scientific method is the formulation of a hypothesis, usually in the form of a mathematical model of some kind. The confidence that the scientist has in the model will vary dence that the scientist has in the model will vary depending on the nature of the application. In the case of environmental pollution problems the degree of confidence is often low. New methods of time-series and systems analysis are introduced that can help in the solution of dynamic systems problems like those encountered in determining pollution dispersion and effects. This approach emphasizes the use of powerful new methods of recursive time-series analysis and the need to avoid wherevery time-series analysis and the need to avoid wherey er possible, prejudicial judgements during model synthesis. The model builder should attempt to build a mathematical model with a size and com-plexity that reflects the information content in the experimental data available from the system. One of the most important aspects of the systems approach is the idea that the modeling should be objective oriented and data-based; i.e., a model should be constructed to satisfy some user-defined objective and should be obtained from the objective and should be obtained from the obj tive analysis of experimental data. In practice, such objectives normally demand both that the model is objectives normally demand out that the model is able to characterize the behavior of the environmental process as it occurs in the real world (rather than as it might occur within a more limited and abstract scientific setting); and that the model should be in a form which can be used within the real world for purposes such as forecasting contextional control and measurement. (See ing, operational control, and management. (See also W91-10406) (White-Reimer-PTT)

# Effects Of Pollution—Group 5C

MIDWEST USE OF PESTICIDES AND CHANGING AGRICULTURAL NEEDS.

Iowa State Univ., Ames. Center for Agricultural and Rural Development.

and Rural Development.

S. R. Johnson.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 5-28. 11 fig, 6 tab, 31

Descriptors: \*Agricultural chemicals, \*Agriculture, \*Crop production, \*Nonpoint pollution sources, \*Pesticides, \*Water pollution control, Administrative regulations, Economic aspects, Environmental policy, Governmental interrelations, Groundwater quality, Pesticide use, Water pollution prevention

Pesticide use in the Midwest is determined largely by the acreages of corn or coarse grains and soy-beans and the technologies used in their producbeans and the technologies used in their produc-tion. These two factors are in turn influenced by a myriad of determinants, including economic condi-tions in markets for agricultural commodities, available production technologies, relative prices of factors of production, and government com-modity programs and policies. Among the govern-mental policies influencing crop acreages and pro-duction technologies are price and income stabili-zation programs for acriculture accessible resisted. tation recommonders are price and medical station zation programs for agriculture, pesticide registra-tion, public support of agricultural research, na-tional fiscal and monetary measures, and state reg-ulations of water use and quality. The complexity ulations of water use and quality. The complexity of the agriculture process and the subtle impacts of government regulation suggest that policy initiatives motivated by concerns for groundwater quality must be carefully researched if anticipated outcomes are to be realized. Policies affecting agriculture and, indirectly, acreage and pesticide use rates appear at least as important in controlling the pesticide load as current registration or the licensing authority of EPA. Integrating pest management with other government programs that influence agriculture is recommended to achieve publicly acceptable, risk levels and environmental conence agriculture is recommended to achieve publicly acceptable risk levels and environmental conditions, along with a low-cost food supply. (See also W91-10423) (MacKeen-PTT) W91-10424

PESTICIDES, GROUNDWATER, AND RURAL DRINKING WATER QUALITY IN IOWA. IOWA Dept. of Public Health, Des Moines. G. R. Hallberg, R. D. Libra, K. R. Long, and R.

G. K. Halloerg, K. D. Lova, R. R. College, and G. C. Splinter.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 83-104. 3 fig, 9 tab, 43 cr

Descriptors: \*Agricultural chemicals, \*Drinking water, \*Groundwater pollution, \*Iowa, \*Path of pollutants, \*Pesticides, Aquifer characteristics, Big Spring Basin, Nitrates, Seasonal variation, Water quality monitoring, Wells.

Since 1980, there has been a concerted effort in Iowa to investigate the impact of agricultural chemicals on groundwater. Initial studies indicated that significant concentrations of nitrate were present in groundwater in the shallow bedrock and karst areas to depths of 150-200 ft, while in bedrock areas, such contamination was largely absent. The Big Spring Basin, a karst-shallow bedrock aquifer in northeast Iowa, has been the subject of more intensive study. Only one insecticide, fono-fos, has been detected in Big Spring Basin groundwater. Its occurrence was related to the karst runin recharge component. The most commonly used herbicides in the area, atrazine, alachlor, cyanazine, metolachlor, were detected in groundwater samples as were, to a lesser extent, metribuzin and 2,4-D. Between 1981 and 1985 from 83 to 89% of the wells monitored in the Big Spring Basin had 2,4-15. Detween 1961 and 1951 from 50 6976 of 1 the wells monitored in the Big Spring Basin had detectable residues of pesticides at some time during a water year. Monitoring at Big Spring has shown that simple infiltration is the major mechashown that simple infiltration is the major mecha-

nism of contaminant delivery. Water quality stud-ies in Floyd and Mitchell Counties, Iowa, indicated nism of contaminant delivery. Water quality stud-ies in Floyd and Mitchell Counties, Iowa, indicated that over 50% of samples from susceptible geolog-ic regions (very shallow bedrock and karst) showed detectable levels of pesticides. Similar re-sults were obtained in studies of alluvial aquifers. Data trends indicate that pesticide residues in groundwater are increasing in Iowa. Seasonal peaks in pesticides detected in groundwater oc-curred during late March to early April, June to July, and October. It is concluded that pesticide residues are now being routinely detected in Iowa's groundwater and surface waters, and that 25% of Iowans now consume drinking water that contains pesticide residues during at least a portion of the year. (See also W91-10423) (MacKeen-PTT) W91-10427

PESTICIDES IN IOWA'S DRINKING WATER.
Iowa Dept. of Environmental Quality, Des

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sonsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 115-135. 1 fig, 13 tab,

Descriptors: \*Agricultural chemicals, \*Drinking water, \*Groundwater pollution, \*Iowa, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*Water pollution sources, Groundwater, Leaching, Pesticide residues, Population exposure, Water quality monitoring, Wells.

The collective and cooperative work of resource agencies in Iowa over the last five years has shown that many commonly used pesticides are leaching through the soil and into groundwater. The most commonly detected pesticides are now routinely detected in the state's primary source of drinking water. Recent investigations suggest that over 25% of the state's population is now exposed to pesticides through consumption of drinking water. cides through consumption of drinking water. Al-though concentrations of various compounds are cides through consumption of drinking water. Although concentrations of various compounds are relatively low, usually less that 2 microg/L, total pesticide concentrations have been known to exceed 60 microg/L. The implications for human health from ingestion of pesticides are not clear. Public water supply systems rely heavily upon groundwater for their source of water in Iowa. However, many of these supplies must obtain their water from aquifers which represent very sensitive hydrogeologic settings. In sum, 33% of all water supply wells sampled in various environments have exhibited pesticide residues. In some geographic regions, over 50% of all public water supply wells are experiencing problems. Recent studies have shown that the best treatment techniques are unable to remove pesticides from the source water. It is concluded that a holistic approach to agricultural management and research will be required to resolve groundwater quality problems related to agriculture. (See also W91-10423) (Author's abstract) stract) W91-10429

MINNESOTA PESTICIDE MONITORING SUR-

VEYS: INTERIM REPORT.
Minnesota Dept. of Health, Minneapolis.
For primary bibliographic entry see Field 5A.
W91-10430

#### 5C. Effects Of Pollution

WATER QUALITY IMPACTS ASSOCIATED WITH WHEAT CULTURE IN THE SOUTHERN

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 4C. W91-09352

LONG-TERM IONIC INCREASES FROM A CENTRAL APPALACHIAN FORESTED WATERSHED.

Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab. For primary bibliographic entry see Field 5B. W91-09353

EVALUATING WATER QUALITY IN THE LOUROS RIVER (GREECE) USING BIOTIC INDICES BASED ON INVERTEBRATE COMMU-

National Centre for Marine Research, Athens (Greece).

T. Koussouris, I. Bertahas, A. Diapoulis, and K. Gritzalis.

Environmental Education & Information EEDIEF, Vol. 9, No. 4, p 163-174, 1990. 4 fig, 1 tab, 11 ref.

Descriptors: \*Aquatic habitats, \*Bioindicators, \*Greece, \*Invertebrates, \*Species composition, \*Stream biota, \*Water pollution effects, Agriculture, Alkalinity, Anoxia, Dissolved oxygen, Drainage area, Field tests, Hardness, Hydraulic conductivity, Hydrogen ion concentration, Loyros River, Nitrates, Water temperature, Wetlands.

The Loyros River is one of the major water sources flowing into the Amvrakikos Gulf, Greece. The river travels through an area of 800 sq Greece. The river travels through an area of 800 sq. m with a huge wetland and agricultural and industrial areas. Drainage works and embankments have changed the water balance in the region, resulting in significant ecological disturbances in the wetland area. Surveys were taken in different seasons during various hydrological regimes and climatic conditions. Seven sampling stations were established on the last 36 km of the river, situated in relation to specific pollution sources. Temperature, dissolved oxygen, pH and conductivity were in relation to specific pollution sources. Temperature, dissolved oxygen, pH and conductivity were measured on the spot with portable instrumentation. The chemical determinations of total alkalinity, total hardness, calcium hardness, chloride and sulfate were done in the laboratory. River water had high levels of oxygen saturation at the surface. The average annual water temperature is 18 C. The pH values range between 6.1 and 8.3, and the river has relatively high alkalinity (150 to 200 mg/L calcium carbonate). Total hardness fluctuated from 210 to 450 mg/L. Nitrates were measured from 886 to 1568 microg/L, nitrites from 8.7 to 161.9 microg/L. The river water quality is well 161.9 microg/L. The river water quality is well within EEC standards, but sometimes exceeds nitrite, ammonia, and phosphate standards. The Loyros River seems to be affected by hydrological Loyros River seems to be affected by nytoriogical regime, climatic conditions, and large volumes of organic effluent. River quality based on the Trent index was nearly clean during May, when the river is still receiving snow melt from the mountains, but degraded during July, when the river flow is low. Snails are very abundant at the sites 5.3 and 27.5 km upstream from the river mouth. The Hynes m upstream from the river moun. The Hynes index showed the river has clean, self-cleaning to clean, and self-cleaning zones. The river shows uneven mixing of water in time and space, with waste water from various anthropogenic and natural activities. (Brunone-PTT)

W91-09363

SOME EFFECTS OF ACIDIFICATION ON PO-LYCELIS FELINA (DALYELL), A FRESHWA-TER TRICLAD (PLATYHELMINTHES). Nottingham Polytechnic (England). Dept. of Life

F. B. Pyatt, J. B. Sykes, C. Gadd, and D. M.

Storey. Environmental Education & Information EEDIEF, Vol. 9, No. 4, p 175-180, 1990. 1 tab, 12

Descriptors: \*Acid rain, \*Acid rain effects, \*Acidification, \*Aquatic habitats, \*Bioassay, \*Platyhelminthes, \*Water pollution effects, Animal physiology, Dissolved oxygen, England, Mortality, Sulfuric acid, Water temperature.

The triclad platyhelminth Polycelis felina is generally found in flowing freshwater habitats. The presence and population parameters of the species are related to a variety of factors, including temare related to a variety of factors, including tem-perature, dissolved oxygen content, and food avail-ability. Low pH levels, often caused by acid pre-

# **Group 5C—Effects Of Pollution**

cipitation, may cause mortality in these platyhel-minths. Water samples were obtained from various parts of England, from sites including canals, rivers, ponds, reservoirs, and lakes. Simulated acid rain was produced, using a mixture of sulfuric acid, hydrochloric acid and nitric acid, and added to the freshwater samples. Acidification of the water samples caused increased mucus secretion by P. felina. Many individuals contracted their bodies, reduced surface area exposed to the solution. Different water samples produced different survival results, reflecting the presence in the sam-ples of additional substances which may have caused synergistic effects. At pH 2.9, no P. felina caused synergistic effects. At pri 2.9, no P. feina survived more than 2 days. Above pH 3.6 mortality was not as marked, and individual P. felina survived for the full seven days of the experiment. The more acidic samples caused behavioral responses, such as vigorous body contortions, and then either mortality or a return to normality. (Brunone-PTT) W91-09364

# RESTORATION OF EUTROPHIED SWISS LAKES.

Water Pollution Control Office of the Canton of Zurich, Walchetor, CH-8090, Zurich, Switzerland. For primary bibliographic entry see Field 5G. W91-09377

# WATERBORNE VIRUSES ASSOCIATED WITH

HEPATITIS OUTBREAK.

Barcelona Univ. (Spain). Facultat de Biologia.

A. Bosch, F. Lucena, J. M. Diez, R. Gajardo, and M. Blasi.

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 80-83, March 1991. 1 fig, 6 tab, 20 ref.

Descriptors: \*Drinking water, \*Enteroviruses, \*Hepatitis, \*Human diseases, \*Human pathogens, \*Path of pollutants, \*Spain, \*Water pollution ef-fects, Chlorination, Contamination, Feces, Rotavir-Water quality monitoring, Water supply,

Human enteric viruses were isolated from the potable water of a military camp in Spain that was experiencing an outbreak of infectious hepatitis, despite a total chlorine residual in the water of 0.2 despite a total cinorine residual in the water of 0.2 mg/L. On February 1, 1988, during the peak of the infectious hepatitis cases, water samples were taken for physicochemical, bacteriological, and virological analysis from 9:45 a.m. to 6:45 p.m. Five uncal analysis from 9:45 a.m. to 6:45 p.m. Five untreated water samples were collected from the 120,000 L reservoir, while tap water was sampled from a camp faucet that had been allowed to flow for several minutes. The bacteriological analysis, a two-day incubation in trypticase soy agar at 30 C for a standard plate count, showed the water to be consistently free of indicator bacteria. Virological analyses were performed for the presence of enterpreservoiruses and benefitie. A The Volice oviruses, rotaviruses, and hepatitis A. The Valira River appears to be contaminated with human netteric viruses. The outbreak of illness at the camp may have been caused by the fecal contamination of the Valira River, which receives occasional wastewater discharges from Andorra, and the inadequacy of the processes used to treat the water. These results support monitoring of viral contamination and more powerful water treatment when viruses have been detected in the water supply. (Brunone-PTT) W91-09407

# SEASONAL REGULATION OF DAPHNIA POPULATIONS BY PLANKTIVOROUS FISH: IMPLICATIONS FOR THE SPRING CLEAR-

WATER PHASE, Wisconsin Univ.-Madison. Center for Limnology. For primary bibliographic entry see Field 2H. W91-09410

# BACTERIAL PRODUCTION ON HUMIC AND NONHUMIC COMPONENTS OF DISSOLVED ORGANIC CARBON.

Georgia Univ., Athens. Dept. of Microbiology. For primary bibliographic entry see Field 2H. W91-09411

FIELD MEASUREMENT OF SPECIFIC GROWTH RATE, BIOMASS, AND PRIMARY PRODUCTION OF BENTHIC DIATOMS OF SAVIN HILL COVE, BOSTON.

Massachusetts Univ. at Boston. Environmental Sci-

For primary bibliographic entry see Field 2L. W91-09412

NITROGENASE ACTIVITY OF MICROCO-LEUS LYNGBYACEUS MAT COMMUNITIES IN A EUTROPHIC, TROPICAL MARINE EN-VIRONMENT.

Puerto Rico Univ., Mayaguez. Dept. of Marin

M. R. Diaz, J. E. Corredor, and J. M. Morrell. Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1788-1795, December 1990. 8 fig, 23 ref.

Descriptors: \*Algal blooms, \*Algal growth, \*Cyanophyta, \*Enzyme activity, \*Eutrophication, \*Marine environment, \*Nitrogen cycle, \*Puerto Rico, \*Water pollution, Ammonia, Diurnal variation, Inorganic nitrogen, Nitrates, Nitrogenacy, Nutrient concentrations, Tropical regions, Wastewater pollution.

Inshore waters at La Parguera, on the southwest-ern coast of Puerto Rico, are subjected to chronic sewage discharges resulting in incipient nearshore eutrophication. Floating and attached cyanobactereutropincation. Floating and attached cyanobacterial mats consisting primarily of Microcoleus lyng-byaceus, a nonheterocystous, filamentous cyano-bacterium, are a permanent feature of the near-shore marine environment at La Parguera, Puerto Rico. Nitrogenase activity in these mat communities, as determined by acetylene reduction, exhibit-ed a diel cycle with daytime inhibition and enhanced nocturnal activity. Contrary to reports garding benthic cyanobacterial mats adapted oligotrophic conditions, nitrogenase activity in M. lyngbyaceus mats is closely regulated by concentrations of ammonia and nitrate ions within the range of values common to their environment. The opportunistic strategy of nitrogen utilization used by M. lyngbyaceus, whereby molecular nitrogen is primarily consumed only in the absence of signifi-cant concentrations of alternate inorganic nitrogen sources, assures the success of these cyanobacterial mat communities. (Author's abstract) W91-09414

# HETEROTROPHIC, AUTOTROPHIC, AND MIXOTROPHIC NANOFLAGELLATES: SEA-SONAL ABUNDANCES AND BACTERIVORY IN A EUTROPHIC LAKE.

Georgia Univ., Athens. Dept. of Zoology.

S. J. Bennett. Limnology and Oceanography LIOCAH, Vol. 35, No. 8, p 1821-1832, December 1990. 4 fig, 3 tab, 22 ref. NSF Grants BSR 84-07928, BSR 88-07382.

Descriptors: \*Eutrophic lakes, \*Flagellates, \*Georgia, \*Limnology, \*Plankton, Dissolved oxygen, Environmental effects, Food chains, Grazing, Lake Oglethorpe, Light intensity, Population density, Seasonal variation, Thermal stratification, Water temperature.

Abundances of heterotrophic (HF), autotrophic (AF), and mixotrophic (MF) nanoflagellates in Lake Oglethorpe, Georgia, were in the range 100 to 10,000 cells/ml. Pigmented and nonpigmented flagellate abundances were positively correlated with each other in samples spanning a year, but were not significantly correlated to the same physical presumers. (supresume supresume light). The cal parameters (temperature, oxygen, light). The highest density of nonpigmented flagellates (> 10,000/ml) was found in spring 1986 at the surface, although most abundance peaks ranged from 4000 to 7000 cells/ml and occurred in the metalimnion during summer stratification. Abundances of pig-mented flagellates (AF + MF) were greatest (900) mented flagellates (AF + MF) were greatest (9000 cells/ml) in surface waters in early spring and late fall when the lake was not stratified. Up to 38% (average 10%) of all pigmented flagellates at any depth also ingested particles, while the percentage of HF that were pigmented flagellates at any depth also ingested particles, while the percentage of HF that were identified as bacterivores ranged from 30 to 100%. In situ grazing rate measurements indi-

cated strong seasonal differences in the relative grazing impact of pigmented and nonpigmented flagellates, with HF dominating grazing on picoplankton except in winter. (Author's abstract) W91-09415

# COMPARISON OF PHYTOPLANKTON BIO-MASS IN TEMPERATE AND TROPICAL LAKES.

Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.

For primary bibliographic entry see Field 2H.

# NITROGEN, PHOSPHORUS, AND NITROGEN FIXATION IN LACUSTRINE AND ESTUA-RINE ECOSYSTEMS.

North Carolina Univ. at Chapel Hill. Dept. of For primary bibliographic entry see Field 2L.

CHLORDANE RESIDUES IN GREAT LAKES LAKE TROUT: ACUTE TOXICITY AND INTERACTION AT THE GABA RECEPTOR OF RAT AND LAKE TROUT BRAIN.

Michigan State Univ., East Lansing. Pesticide Re-

For primary bibliographic entry see Field 5B. W91-09424

HIGHLY CARBOXYLATED PORPHYRINS AS A BIOMARKER OF POLYHALOGENATED AROMATIC HYDROCARBON EXPOSURE IN AROMATIC HYDROCARBON EAPOSURE IN WILDLIFE: CONFIRMATION OF THEIR PRESENCE IN GREAT LAKES HERRING GULL CHICKS IN THE EARLY 1970'S AND IMPORTANT METHODOLOGICAL DETAILS.

Canadian Wildlife Service, Ottawa (Ontario For primary bibliographic entry see Field 5B. W91-09425

# ECOTOXICOLOGY OF OIL PRODUCTS: PREPARATION AND CHARACTERIZATION OF AQUEOUS TEST MEDIA.

OF AQUEOUS TEST MEDIA.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
D. Bennett, A. E. Girling, and A. Bounds.
Chemosphere CMSHAF, Vol. 21, No. 4/5, p 659-669, 1990. 4 fig, 4 tab, 17 ref.

Descriptors: \*Oil pollution, \*Petroleum products, \*Toxicity, \*Toxicology, \*Water analysis, \*Water pollution effects, Chemical analysis, Gas liquid chromatography, Mass spectrometry, Path of pollutants, Separation techniques, Solubility.

Published guidelines for determining aquatic toxic-ity are only appropriate for chemical products tested below the limit of their water solubility. Oil tested below the limit of their water solubility. Oil based products contain multiple constituents with differing solubilities, and in order to obtain valid results, all components must be properly represented and characterized in the aqueous test media. In this study of two formulated oil products, the mixing time required to achieve equilibrium between the concentrations of components in the oil and aqueous phase was determined using total organic explora analysis and total peak ages integraganic carbon analysis and total peak area integra-tion of gas-liquid chromatograms. Individual constituents present in the aqueous phase were further examined by gas-liquid chromatography combined with mass spectrometry, and aqueous phase com-position was also compared with solutions of oil products in dichloromethane. The results demon-strate the attainment of equilibrium concentrations strate the attainment of equilibrium concentrations of oil product components in aqueous phases as well as differences in the composition of the aqueous phase compared with the oil products themselves. The predominant constituents in the aqueous phase were chemical additives and not the base oils. (D'Agostino-PTT)
W91-09433

FIRST VALIDATION OF A MODEL FOR THE ADSORPTION OF LINEAR ALKYLBENZENE-

# Effects Of Pollution—Group 5C

SULFONATE (LAS) TO SEDIMENT AND COM-PARISON TO CHRONIC EFFECTS DATA. Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept. For primary bibliographic entry see Field 5B. W91-09437

EFFECTS OF POLYDIMETHYLSILOXANE (PDMS) IN SEDIMENT ON THE POLY-CHAETE WORM, NEREIS DIVERSICOLOR. Imperial Chemical Industries Ltd., Brixham (England). Group Environment Lab. N. C. D. Craig, and J. E. Caunter. Chemosphere CMSHAF, Vol. 21, No. 6, p 751-759, 1990. 1 fig, 4 tab, 10 ref.

Descriptors: \*Organosilicon compounds, \*Polychaetes, \*Polydimethylsiloxane, \*Sediment contamination, \*Toxicity, \*Toxicology, \*Water pollution effects, Aquatic life, Organic compounds, Path of pollutants, Sediments, Siliconated hydrocar-

The previously reported effects of organosilicon compounds on marine and freshwater biota refer predominantly to the toxicity of these compounds in aqueous solution or suspension. Since polydiin aqueous solution or suspension. Since polydi-methylsiloxane (PDMS) fluids are only sparingly methylsiloxane (PDMS) fluids are only sparingly soluble and less dense than water, they can potentially form a discrete surface layer if discharged, resulting in deposition on intertidal sediments. In the present study, exposure of the polychaete, Nereis diversicolor, to 10,000 mg/kg of PDMS caused no deaths in 96 hrs, and to 1,000 mg/kg resulted in no deaths over 28 days. There appears to be no short or medium term toxic effects of PDMS fluids on this intertidal invertebrate species. (D'Agostino-PTT) (D'Agostino-PTT) W91-09438

CHANGES IN MISSISSIPPI RIVER WATER QUALITY THIS CENTURY: IMPLICATIONS FOR COASTAL FOOD WEBS.

Louisiana State Univ., Baton Rouge. Coastal Ecol-

ogy Lab.
R. E. Turner, and N. N. Rabalais.
Bioscience BISNAS, Vol. 14, No. 3, p. 140-147,
March 1991. 9 fig, 45 ref. Louisiana Board of
Regents Education Quality Support Fund Grant
LEQSF(1987-90)-RD-A-15.

Descriptors: \*Coastal environment, \*Eutrophica-tion, \*Fertilizers, \*Food chains, \*Mississippi River, \*Phytoplankton, \*Water pollution effects, \*Water quality trends, Algal growth, Ammonia, Diatoms, Environmental policy, Lakes, Nitrates, Nitrogen, Phosphorus, Reviews, Rivers, Silicon, Streams, Water pollution sources.

Water quality in the Mississippi River has changed this century as a result of watershed changes and fertilizer use. The causes and potential impacts of these changes are demonstrated by a review of published and unpublished water quality data, focusing on three indicators: phosphorus, silicon, and nitrogen (as nitrate). Water quality changes are coincident with increased nitrogen and phosphorus fertilizer use. When fertilizer use reached a plateau, both the ries in river nitrate concentration and the both the rise in river nitrate concentration and the fall in silicate concentration stopped. The rise in of watershed land to store the mostly ammonia-based nitrogen fertilizers was exceeded. The coin-cidental decline in silicate as phosphorus fertilizer osset introgen terminers was executed. The comi-cidental decline in silicate as phosphorus fertilizer application increased supports the hypothesis that freshwater diatom growth in the streams and lakes feeding the main river channel is stimulated by phosphorus additions, and that the increased diatom growth leads to a net loss of silicon from the water column. The increase in nitrogen (and possibly phosphorus) and the reduction of silicon have profound implications for coastal phytoplankton communities, and are likely to result in increased phytoplankton production in the otherwise nitrogen-limited oceanic food web. It is concluded that the national policy of phosphorus control has not halted the advance of eutrophication in fresh water, and that the policy is incomplete because it focuses on freshwater systems to the exclusion of coastal phytoplankton ecosystems. (Doria-PTT) W91-09451

EXPERIMENTAL EVALUATION OF FOOD CHAIN MANIPULATION AS A MEANS FOR PREVENTING ALGAL BLOOMS IN LAKES, Purdue Univ., Lafayette, IN. Water Resources Re-For primary bibliographic entry see Field 5G. W91-09469 search Center.

LONG-TERM EFFECTS OF SURFACE COAL MINING ON GROUND-WATER LEVELS AND QUALITY IN TWO SMALL WATERSHEDS IN EASTERN OHIO.

Geological Survey, Columbus, OH. Water Re-For primary bibliographic entry see Field 5B. W91-09556 sources Div.

ALTERATIONS IN RAS-GENE EXPRESSION AND INTRACELLULAR DISTRIBUTION OF PROTEIN KINASE C IN THE SPONGE GEODIA CYDONIUM IN RESPONSE TO MARINE POLLUTION.

Institut fur Physiologische Chemie, Abteilung Angewandte Molekularbiologie, Universitat, Dues-bergweg 6, D-6500 Mainz, Germany. D. Ugarkovic, B. Kurelec, S. Krea, R. Batel, and A. Robitzki.

Marine Biology MBIOAJ, Vol. 107, No. 2, p 191-197, 1990. 2 fig, 1 tab, 52 ref.

Descriptors: \*Enzymes, \*Genetics, \*Marine pollu-tion, \*Sponges, \*Water pollution effects, \*Yugo-slavia, DNA polymerase, Environmental physiolo-gy, Gene translocation, Geodia, Marine environ-ment, Protein kinase, Signal transduction.

The influence of marine pollution on intracellular signal transduction in the siliceous sponge Geodia cydonium Jameson was investigated at six seawater sites around Rovinj, Yugoslavia. Transplantation of regenerating sponge cubes to polluted areas resulted in pronounced changes in the intracellular distribution of protein kinase C (PK-C) area-gene expression, and DNA polymerase alpha (DNA POL alpha) activity. Although ras-gene expression was increased three-fold to five-fold at some polluted sites, the ras mRNA level was reduced about 50% at the site with the highest pollutional load. PK-C translocated from the cyto-solic to the membrane fraction in response to pollution, but at the most impacted site most of the enzyme activity was cytosolic. DNA Pol alpha activity, used as a measure of sponge cell proliferation, decreased in a pollution-correlated manner. Combined results indicate that the signalling The influence of marine pollution on intracellular tion, decreased in a pollution-correlated manner. Combined results indicate that the signalling system within sponge cells is activated in response to moderate pollution but is depressed in heavily polluted environments. (D'Agostino-PTT) W91-09679

COST OF NOT HOLDING BACK THE SEA: TOWARD A NATIONAL SAMPLE OF ECONOMIC VULNERABILITY.

Wesleyan Univ., Middletown, CT. G. Yohe. Coastal Management CZMJBF, Vol. 18, No. 4, p 403-431, 1991. 5 fig. 15 tab, 29 ref, append. U.S. Environmental Protection Agency Cooperative Agreement Number CR-814927-01-0.

Descriptors: \*Coastal waters, \*Economic evalua-tion, \*Economic prediction, \*Global warming, \*Greenhouse effect, \*Sea level, Coastal zone man-agement, Economic impact, Flood damage, Flood forecasting, Flood risk, Water level fluctuations.

Increased atmospheric concentrations of radiatively active gases are expected to cause the mean global temperature to rise 2 to 5 C over the next century. The effects and global distribution of this greenhouse warming are likely to be widespread and uneven, and the understanding of their social, economic, and political ramifications is clouded by the enormous uncertainty with which their future trajectories are viewed. National and regional estimates of U.S. economic vulnerability to greenhouse-induced sea-level rise were produced from a sample of 30 discrete regions scattered evenly along the coastline. Scenarios that envision 50 cm, 100 cm, and 200 cm of greenhouse-induced sea-Increased atmospheric concentrations of radiative-

level rise were considered. These scenarios can be expected to place \$39.2, \$65.6, and \$133.3 billion, respectively, (1989 dollars) of existing development in jeopardy through the year 2050; and \$133.3, \$308.7, and \$909.4 billion through 2100. Sampling error and consideration of the uncertainty with which future greenhouse-induced sea-level rise is currently viewed places the 25th and 750. ty with which future greenhouse-induced sea-level rise is currently viewed places the 25th and 75th percentile values of expected cumulative vulnerability at \$38.5 and \$76.7 billion through 2050 and \$132.6 and \$362.4 billion through 2100. Not surprisingly, the southeast displays the largest potential vulnerability, with the northeast ranking second above both the Gulf coast and the west coast (Author's abstract). coast. (Author's abstract) W91-09696

LONG-TERM EFFECTS OF HIGH APPLICA-TION RATES OF NPK FERTILIZER ON TEN-SILE STRENGTH AND WATER STABILITY OF THE SOIL STRUCTURE.

Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water. A. Hadas, A. Hadas, and J. Quinton

A. riauss, A. riauss, and J. Quinton. Geoderma GEDMAB, Vol. 47, No. 3/4, p 381-392, December 1990. 5 tab, 26 ref. United States-Israel Binational Agricultural Research and Devel-opment Fund (BARD) grant No. 1-812.84.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Fertilizers, \*Soil contamination, \*Soil structure, \*Water pollution effects, Biomass, Fertilization, Soil aggregates, Soil density, Soil organic matter, Soil stability, Soil strength.

Intensive agricultural practices are thought to cause soil structure deterioration. A study was cause soil structure deterioration. A study was performed of the long-term effects exerted by high application rates of N,P,K fertilizer on soil structure as characterized by tensile strength, stability to water, friability, and bulk density of its structural units. Long-term fertilization with N, P, and K fertilizers did not significantly change the organic C content of the soil and, in spite of the differences in N, P, and K application rates and the different organic debris and residues incorporated in the soil, soil structure did not show differential stability to water. Increased biomass found with an inty to water. Increased biomass found with an inty to water. Increased blomass found with an increase in aggregate diameter and levels of N,P,K application can be attributed to the increased porosity of larger aggregates and increased N,P,K levels, but these did not lead to improved soil structure stability to water or internal strength. The high incorporation rates of calcium as a result of the addition of heavy rates of magnifications. of the addition of heavy rates of superphosphate may have led to a more friable soil, as observed from the estimates of tensile strength of the bulk soil, the volumetric and weighted median aggregate diameters. (Fish-PTT) W91-09700

CLOSED FLOW-THROUGH AQUATIC TOXIC-ITY TESTING AND MICROSCOPIC ORGA-NISMS: NOT NECESSARILY INCOMPATIBLE. California Univ., Santa Cruz. Inst. of Marine Sci-

R. S. Tjeerdema, and M. M. Singer. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 59-61, February 1991. 1 fig, 1 tab, 13 ref.

Descriptors: \*Bioindicators, \*Environmental moni-toring, \*Microorganisms, \*Testing procedures, \*Toxicity, \*Toxicology, \*Water pollution effects, Dissolved oxygen, Growth stages, Hydrogen ion concentration, Laboratory equipment, Sampling, Water quality.

An exposure system for testing toxicity with mi-croscopic organisms under closed, continuous-flow conditions uses teflon gas sampling bags to mini-mize chemical volatilization and eliminate transfer steps. The exposure chamber is a cylinder of boro-tillest allegation of the control of th silicate glass with a tellon and glass stopcock mounted on top and sintered glass fritted disks at each end. Two-piece design allows chamber access before and after testing for collection of organisms, order and and resum for order testing apparatus, and cleaning. Over the past two years, toxicity tests involving both constant and spiked-exposure regimes have yielded highly reproducible results

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using this system. Important water quality parameters were also quite stable: in both investigations, dissolved oxygen concentrations were always above 72% saturation, and overall pH values varied by less than 0.5 pH units. By minimizing both the biological and chemical aspects of aquatic toxicity testing, the most conservative (and thus environmentally protective) toxicity values may now be obtained. Such values, obtained by using now be obtained. Such values, obtained by using both sensitive life stages and a closed flow-through exposure system, will allow a more conservative assessment of the true environmental risks posed by toxic organic mixtures, which may be much more cost-effective. (Doria-PTT)

FIELD ASSESSMENT OF BIOMARKERS FOR

WINTER FLOUNDER.
Battelle Ocean Sciences, Duxbury, MA.
R. S. Carr, R. E. Hillman, and J. M. Neff.
Marine Pollution Bulletin MPNBAZ, Vol. 22, No. p 61-67, February 1991. 3 fig, 5 tab, 24 ref. NSF Grant OCE 81-11949.

Descriptors: \*Bioindicators, \*Boston Harbor, \*Flounders, \*Tissue analysis, \*Wastewater pollution, \*Water pollution effects, \*Water pollution sources, Amino acids, Blood, Effluents, Fins, Fish physiology, Glucose, Glycogen, Histology, Lipids, Liver, Massachusetts, Muscle, Sludge disposal, Statistical analysis, Water quality.

Winter flounder, Pseudopleuronectes americanus, from Boston Harbor near the Deer Island sewage outfall and from a nearby reference population near Plymouth Beach, Massachusetts, were collected on several occasions and analyzed for a variety of biochemical variables and histopatholo-gical conditions. A number of biochemical varia-bles including hepatic and pectoral fin ascorbic acid concentrations, hepatic glycogen and lipid levels, plasma glucose concentrations, and the con-centration and ratio of various free amino acids in muscle tissue were significantly different between the two populations. The primary histological dif-ference between winter flounder from Boston Harbor and those from Plymouth Beach was the high prevalence of apparent apoptotic hepatic pa-renchymal cells in the Boston Harbor fish. Low tissue concentrations of ascorbic acid and hepatic glycogen were found to have significant statistical associations with the presence and severity of these hepatic lesions. Because these populations are believed to be relatively discrete and the water quality parameters essentially identical between the two sites, it may be speculated that the biochemical and histological differences observed between the two populations result from conditions arising from the discharge of primary effluent and sewage sludge at the Boston Harbor site. (Doria-PTT) W91-09757

OCCURRENCE OF INTERSEXUALITY IN HARPACTICOID COPEPODS AND ITS RELA-TIONSHIP WITH POLLUTION. Heriot-Watt Univ., Edinburgh (Scotland). Dept. of

Biological Sciences.
C. G. Moore, and J. M. Stevenson.
Marine Pollution Bulletin MPNBAZ, Vol. 22, No.
2, p 72-74, February 1991. 2 fig. 16 ref.

Descriptors: \*Coastal environment, \*Copepods, \*Edinburgh, \*Effluents, \*Imposex, \*Outfall, \*Wastewater pollution, \*Water pollution effects, lays, Domestic wastes, Estuaries, Industrial vastes, Parasitism, Water pollution sources.

Intersexuality in harpacticoid copepods is extreme-Intersexuality in narpacticoid copepods is extreme-ly rare, only one specimen having been recorded in the literature over 40 years ago. In January 1988, two core samples were taken from the Firth of Forth (Scotland) within 100 m of the diffuser of the Edinburgh long-sea sewage outfall. Param-phiascella hyperborea was one of the dominant copepod species present; of 30 specimens, 28 were intersexes. Subsequent examination of samples intersexes. Subsequent examination of samples taken from off the Edinburgh coast have revealed taken from on the cumourgn coast have tweened only one further specimen of Paramphiascella (an intersex), but additional samples have included small numbers of intersexes of Stenhelia gibba and Halectinosoma similidistinctum. Two intersex

specimens of P. hyperborea have also been found in Loch Creran about 3 km downstream from an alginate factory discharge and a single intersex of P. hyperborea from a site lacking any obvious source of pollution on the Island of Mull. A causative relative the control of the contr tive relationship between intersexuality and chemi-cal pollution is a strong possibility. The Forth estuary in general and the long-sea outfall in par-ticular receives a wide variety of industrial and domestic effluents, so that it is currently impossible to identify the possible causative agents. Parasitism may be involved in the production of the phenomenon, although no trace of internal parasites has been observed in any of the specimens. (Doria-PTT) W91-09759

REACTIONS OF SAND SMELT TO LOW PH SEA-WATER.

National Power, Fawley (England). Marine Biology Unit.
J. K. Davies.

Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 2, p 74-77, February 1991. 3 fig, 15 ref.

Descriptors: \*Acidic water, \*Coastal waters, \*Powerplants, \*Smelt, \*Water pollution effects, Effluents, Fish, Fish behavior, Growth stages, Hydrogen ion concentration, Mortality, Seawater, Sublethal effects, Sulfuric acid, Temperature, Tox-

A method for scrubbing flue gases at coastal power stations termed 'seawater washing' would produce acid effluents for sea disposal. Since the normal pH range of seawater is around 7.8-8.2, an investigation was undertaken to determine pH levels at which fish could detect and avoid acidified seawater and whether this response occurred at sublewater and whether this response occurred at subfe-thal acidity levels. An apparatus was set up within a fish behavior flume consisting of an enclosed arena through which flowed seawater dosed on one side with sulfuric acid. The fish (Atherina boyeri) were thus presented with two areas of water, one acidic and the other untreated. Both water, one acidic and the other untreated. Both adult and juvenile fish showed no avoidance response until the pH on the acidified side of the arena was lowered to 6.5-6.6. The nature of the response was an irritant one, with rapid exit of the fish from the acidic side at these levels. The fish returned to the previously acidic area upon cessation of dosing. No fish were found dead as a result of exposure to the experimental regime either during, or within 48 h after, the experimental period. No differences were found between the behavior of adults and juveniles towards the conditions imposed, nor differences in response to seations imposed, nor differences in response to sea-sonal temperature changes (14.6-7.8 C). It is con-cluded that seawater washing is a viable option provided that measures are taken to alleviate potential deleterious effects of acidic discharges on the marine ecosystem. (Doria-PTT) W91-09760

OCCURRENCE OF CYPRINIDAE AND OTHER SMALL FISH SPECIES IN RELATION

TO PH IN ONTARIO LAKES.
Ontario Ministry of Natural Resources, Toronto.
Fisheries Branch.
J. E. Matuszek, J. Goodier, and D. L. Wales.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 5, p 850-861, September 1990. 8 fig, 2 tab, 45 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Bioindicators, \*Carp, \*Fish, \*Lake acidification, \*Water pollution effects, Fish physiology, Hydrogen ion concentration, Lakes, Metabolism, Minnows, Population density, Sculpin, Shiner, Species composition

Data from 426 Ontario lakes were used to determine how the number of fish species in a lake is empirically related to lake area and pH. In lakes of pH 6.0 and above, the total number of species increased with lake area, whereas the number of cyprinid species was generally unrelated to lake size. As a result, the fraction of cyprinid species in the total species count decreased with increasing lake size. When these effects of lake size were taken into account, the total number of species, the

total number of cyprinid species, and the cyprinid total number of cyprinid species, and the cyprinid fraction all decreased below pH 6.0. An augmented set of 488 lakes was used to evaluate 13 common small (up to 10 cm total length) fish species as potential early indicators of changes in the fish community due to acidification. The most recognitive indicator section were fethaged minrous. promising indicator species were fathead minnow (Pimephales promelas), common shiner (Notropis cornutus), bluntnose minnow (P. notatus), blacknose shiner (N. heterolepis), and slimy sculpin (Cottus cognatus). The usefulness of small fish species as early warning indicators may extend to harmful environmental changes other than acidification, because they have faster metabolic processes per unit weight than larger fishes. Furthermore, many small fish species inhabit the nearshore areas of lakes where toxic compounds often enter the lacustrine environment. (Doria-PTT)

CHEMICAL SUITABILITY OF SUBSTRATES FOR WALLEYE EGG DEVELOPMENT IN THE LOWER FOX RIVER, WISCONSIN.

Michigan Technological Univ., Houghton. Dept. of Biological Sciences.

M. T. Auer, and N. A. Auer.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 5, p 871-876, September 1990. 3 fig. 1 tab, 22 ref. USEPA Environmental Research Laboratory-Duluth Project D84-003.

Descriptors: \*Fish management, \*Fox River, \*Pi-Descriptors: \*Pish management, \*Pox River, \*Pisheperch, \*Sediment contamination, \*Spawning, \*Substrates, \*Water pollution effects, Ammonia, Chemical oxygen demand, Dams, Dissolved oxygen, Fish, Fish eggs, Hatching, Hydrogen sulfide, Reproduction, Rivers, Sediment-water interfaces, Sediments, Soil types, Toxicity, Water chemistry, Wisconsin.

Site suitability for egg development was assessed for walleyes, Stizostedion vitreum, in the Fox River, Wisconsin. Water chemistry at the sediment-water interface was compared with criteria for walleye egg hatch success (oxygen and hydro-gen sulfide) and chronic toxicity (free ammonia). Reduced concentrations of dissolved oxygen and elevated concentrations of ammonia-nitrogen and hydrogen sulfide occurred above some sand and all soft muck substrates. The chemical oxygen demand (COD) of the surficial sediments was a uemand (COD) of the surricial sectiments was a useful surrogate variable for identifying the chemical suitability of spawning sites; locations with a surficial sediment COD less than 40 mg O2/g dry weight were considered suitable. A comprehensive surficial sediment survey of the lower Fox River below the DePere Dam showed that optimal walleye spawning habitat (gravel-cobbled substrate) is rare (less than 3% of the area) and that 75% of the suboptimal (sand and muck) substrate is chemically suboptimal (sand and muck) substrate is chemically unsuitable for walleye egg development. It is concluded that successful natural reproduction by walleye in this portion of the lower Fox River is limited by the availability of suitable substrate. (Doria-PTT) W91-09767

PRELIMINARY EVALUATION OF THE EF-FECTS OF AN ABANDONED OIL REFINERY ON CHEMICAL QUALITY OF WATER IN THE ARKANSAS RIVER VALLEY, ARKANSAS CITY, KANSAS, 1985-86.

Geological Survey, Lawrence, KS. Water Resources Div. For primary bibliographic entry see Field 5B.

W91\_09832

COSTS OF GROUNDWATER CONTAMINA-

Environmental Protection Agency, Washington,

W. B. O'Neil, and R. S. Raucher. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 180-183, 1990. 11 ref.

Descriptors: \*Cost analysis, \*Cost-benefit analysis, \*Costs, \*Groundwater pollution, \*Remediation, Path of pollutants, Pricing, Public health, Research

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priorities, Water demand, Water pollution management, Water pollution prevention, Water use.

Two factors determine the cost of groundwater contamination: (1) the ways in which water was being used or was expected to be used in the future and (2) the physical characteristics of the setting that constrain the responses available to regain lost uses or to prevent related damages to human health and the environment. Most contamination health and the environment. Most contamination incidents can be managed at a low enough cost that uses will not be foreclosed. It is important to take into account the following when considering costs: (1) Natural cleansing through recharge and dilution can take many years. (2) It is difficult and costly to identify the exact area and expected path of a contamination plume. And (3) treatment or replacement of contaminated water often may repreplacement of contaminated water often may rep-resent the cost-effective strategy for managing the event. The costs of contamination include adverse health effects, containment and remediation, treatment and replacement costs. In comparing the costs and benefits of prevention programs with those of remediation, replacement or treatment, it is essential to adjust the cost/benefit numbers by the probability of their actual occurrence. Better forecasts of water demand are needed to predict torecasts of water demand are needed to predict more accurately the scarcity of new supply and the associated cost of replacement. This research should include estimates of the price elasticity of water demand and the possible effect on demand of more rational cost-based pricing structures. Research and development of techniques for in situ remediation should be encouraged. (Feder-PTT) WOLOGOST. W91-09867

GROUNDWATER POLLUTION'S ON RESIDENTIAL PROPERTY PORTAGE COUNTY, WISCONSIN. P. Malone, and R. Barrows. EFFECTS VALUES.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 346-348, 1990. 1 tab, 1 ref.

Descriptors: \*Economic evaluation, \*Economic "Reconomic evaluation, "Economic impact, "Groundwater pollution, "Property value, "Water pollution effects, "Wisconsin, Filters, Nitrates, Portage County, Pricing, Real estate transfers, Wells.

Nitrate pollution of groundwater had no statistically significant effect on the price of residential property in a study in Portage County, Wisconsin. These results, however, do not mean that groundwater pollution has no cost. Sellers may be forced to wait longer to sell it to a buyer who is uninto wait longer to sell it to a buyer who is unin-formed or simply does not care about nitrate pollu-tion, so the cost of pollution may be denominated in time rather than sale price. A closer examination of market processes suggests that sellers may also absorb pollution costs by drilling new wells or purchasing filters in response to demands from realtors, lenders or buyers. Groundwater pollution costs do not appear in property prices but are likely absorbed in other ways. (Author's abstract)

LONG-TERM FIELD RESEARCH ON WATER

AND ENVIRONMENTAL QUALITY.
Agricultural Research Service, Durant, OK.
Water Quality and Watershed Research Lab.
R. G. Menzel.

Agronomy Journal AGJOAT, Vol. 83, No. 1, p 44-49, January/February 1991. 47 ref.

Descriptors: \*Acid rain, \*Agricultural watersheds, \*Air pollution, \*Environmental quality, \*Path of pollutants, \*Soil contamination, \*Water pollution effects, Agriculture, Groundwater pollution, Lakes, Model studies, Nutrients, Pesticides, Reviews, Rivers, Runoff, Soil erosion, Water quality,

Long-term field research on environmental quality related to agriculture: water quality, air pollution and soil degradation, is reviewed. Maintaining en-vironmental quality has a high national priority, and is particularly important for agriculture. The deterioration of environmental quality, in most respects, has proceeded almost imperceptibly. Long-term research is required to study effects that change slowly with time, such as contamination of groundwater, or that depend upon infrequent weather events, such as water erosion of soil.

Much environmental quality research involves
long-term measurements of runoff and soil erosion because these are the dominant mechanisms for transporting nutrients and pesticides to rivers and lakes. Water and environmental quality studies are being made at sites ranging from small field plots being made at sites ranging from small field plots to large watersheds and experimental lakes. Effects of acid rain are being studied mainly at watershed and lake sites. There has been little long-term groundwater quality research on agricultural areas, but a major investigation of nitrate and pesticide out a major investigation or intrate and pesticite movement is getting under way. Long-term field research is essential to confirm and refine the pre-dictions derived from environmental models. (Au-thor's abstract) W91-09911

DISTRIBUTION AND STRUCTURE OF BENTHOS IN THE LOWLAND ZEGRZYNSKI RESERVOIR,

Polish Academy of Sciences, Lomianki. Dept. of Hydrobiology. For primary bibliographic entry see Field 2H. For primary W91-09921

HYDROBIOLOGICAL CHARACTERISTIC OF THE LOWLAND, RHEOLIMNIC WLOCLAWEK RESERVOIR IN THE VISTULA

RIVER, Nicholas Copernicus Univ. of Torun (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 2H.
W91-09926

MICROBIAL GROWTH AND ACTIVITY DURING THE INITIAL STAGES OF SEA-GRASS DECOMPOSITION.

Virginia Univ., Charlottesville. Dept. of Environmental Sciences

For primary bibliographic entry see Field 2L. W91-09934

EFFECT OF ORGANIC FERTILIZERS ON MI-

CROFLORA OF A POLLUTED SOIL.
Belorussian Academy of Sciences, Minsk. Inst. of Microbiology.
N. L. Markova, A. S. Samsonova, and T. G. Zimenko.

Soviet Soil Science SSSCAE, Vol. 22, No. 6, p 34-41, 1990. 1 fig, 5 tab, 17 ref. Translated from Pochvovedeniye, No. 4, pp 73-80, 1990.

Descriptors: \*Fertilizers, \*Manure, \*Microflora, \*Soil contamination, \*Tannery wastes, \*Toxic wastes, Actinomyces, Bioindicators, Detoxification, Food chains, Methanol, Model studies, Soil organisms.

The effect of manure, the most widely known organic fertilizer, and tannery waste on the composition and activity of the microbial community of a soil polluted with wastes discharged from a corporation producing the synthetic fiber Lavsan were compared. These wastes included toxic substances compared. These wastes included toxic substances such as methanol, acetaldehyde, ethylene glycol and p-xylene, and also dimethyl terephthalate which has genetic effects on both animals and man through the food chain. Investigations were conthrough the food chain. Investigations were conducted in model pot experiments. Before sowing barley, methanol (10 mg/100 g of soil) and a combination of dimethyl terephthalate, methanol, ethylene glycol and p-xylene (10 mg each) were introduced into the pot soil. Tannery waste (4.16% N, 8.5% water) was applied at a level of 1 g active ingredient per pot. The results showed a decrease in abundance of microorceanisms using minerals and ent per pot. The results showed a decrease in abundance of microorganisms using minerals and organic nitrogen, and an increase in the abundance of soil microorganisms using mineral nitrogen, par-ticularly actinomycetes, which serves as a bioindi-cator, at levels of contamination with methanol mixed pollutants from Lavsan production. nannery waste, an organic fertilizer, stimulated the activity of the microflora and significantly increased the abundance of actinomycetes in polluted soils, thereby promoting the detoxification process and decomposition of methanol. (Medina-PTT) Tannery waste, an organic fertilizer, stimulated the

W91-09948

EFFECT OF BORON AND COPPER CONTAMINANTS IN POULTRY MANURE ON THE GROWTH OF THE COMMON MUSHROOM, AGARICUS BISPORUS,

NSW Agriculture & Fisheries, P.M.B. 10, Rydal-mere, N.S.W. 2116, Australia. For primary bibliographic entry see Field 5E. W91-09950

OLIGOTROPHICATION, LAKE DEVELOP-MENT ALONG WITH ACIDIFICATION. Helsinki Univ. (Finland). Dept. of Limnology For primary bibliographic entry see Field 2H.

INFLUENCE OF SOME NATURAL AND AN-THROPOGENIC FACTORS ON THE RATE OF LAKE EUTROPHICATION.

Institute of Physical Planning and Municipal Economy, Drzymaly 24, 60-613 Poznan, Poland. For primary bibliographic entry see Field 2H. W91-09979

RECENT TROPHIC CHANGES AND PHYTO-PLANKTON COMPOSITION IN LAKE DRUM-MOND, WITHIN THE DISMAL SWAMP, VIR-GINIA.

Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.

For primary bibliographic entry see Field 2H. W91-09982

DIRECTIONS OF SUCCESSION OF BALTIC VEGETATION.

Gdansk Univ. (Poland). Inst. of Oceanography. M. Plinski.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 56-60, 1990. 6 ref.

Descriptors: \*Algal blooms, \*Aquatic plants, \*Baltic Sea, \*Coasts, \*Estuaries, \*Eutrophication, \*Plant populations, \*Succession, \*Vegetation establishment, \*Water pollution effects, Cyanophyta, Ecosystems, Species composition, Species diversi-

Succession in the Baltic region follows several different patterns. One type is an incidental succession associated with a small segment of the biocension associated with a small segment of the olocen-osis. The duration of this type of succession is short, and its effect in the balancing of the land-scape through growth in previously uninhabited places. Another type of succession is the so-called climax biocenosis, a result of the instability of environmental conditions. These changes are usuenvironmental conditions. I nese changes are usu-ally gradual and one-directional, and may exhibit cyclic changes; they often have traits of regressive succession. In recent decades changes in the com-position and number of phytocenoses--plants as well as zooplankton and bottom fauna--of the southern Baltic have been caused by occanization, i.e. the creates of the number of see forms and by i.e., the growth of the number of sea forms, and by eutrophication. Eutrophication is especially intense in regions close to estuarine and coastal areas. As an example of the changes in phytoplankton struc-ture, in the Bay of Szczecin in the 1950's, the dominant species contributing to blue-green algal blooms was Aphanizomenon flos-aquae, accompablooms was Aphanizomenon Iros-aquae, accompa-nied by a 20% share of Microcystis aeruginosa. By the 1960-70's M. aeruginosa constituted over 85% of the share of summer blooms. In the open waters of the Baltic, the blue-green blooms which have been forming since the beginning of this century-A. flos-aquae and Nodularia spumigena—have been A. nos-aquae and Nodularia spunngena-nave ocen supplemented with increasing intensity by M. aeru-ginosa. Similar changes in the phytoplankton struc-ture, i.e., the regression of some species and inten-sive growth of new species, over the last 20-25 years are observed in the Bay of Gdansk and Bay of Puck. (Sand-PTT) W91-09984

CAUSES OF CHANGES IN THE COMMUNI-TIES OF ALGAE IN POLAND.

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Polish Academy of Sciences, Krakow. Inst. of Botany.

J. Sieminska.

Uniwersytet Im. Adama Mickiewicza W Poznan, Seria Biologia Nr 43, Vol. 43, p 61-66, 1990. 7 ref.

Descriptors: \*Acid rain effects, \*Algae, \*Dam effects, \*Eutrophication, \*Mine drainage, \*Poland, \*Thermal pollution, \*Wastewater pollution, \*Water pollution effects, Cooling water, Fertilizers, Industrial wastes, Land use, Marshes, Municipal wastes, Navigation, Peat bogs, Pesticides, Ponds, Powerplants, Rivers, Species composition, Species diversity, Swamps, Water pollution sources.

Profound alterations in the composition of algae in water bodies in Poland are attributed to several causes: pollution by municipal and industrial wastes, eutrophication caused by the extensive use of fertilizers in agriculture and by the inflow of mineralized sewage from treatment plants, and the warming of waters by the inflow of cooling waters from electric power plants. In rivers, factors contributing to changes in algae composition are the increasing amounts of salts (NaCl, MgCl2) resulting from the pumping out of significant quantities of saline Tertiary waters from mines which dip into still deeper layers of the earth, the regulation and reinforcement of river banks, the levelling of river beds, dam building and strong variations in the water flow depending on the work of power plants, and the construction of water steps to faciliate navigation. Peat bogs, previously abundant, have disappeared as a result of the exploitation of peat used for agriculture. Small natural ponds, marshes, and swamps are frequently filled with municipal trash and leveled. From the process of draining and drying, lakes become shallow and disappear, and the level of groundwater and water level in rivers and wells also falls. Algae in the Polish part of the Baltic Sea are often strongly influenced by the flow of sewage from harbors, towns and villages, and oil refineries. Other influences are the discharges from ships and waster flowing into the sea from rivers from the interior of Poland. The species composition of soil algae has also changed as a result of fertilizers, pesticides, industrial pollution, and acid rain. (Sand-PTT)

ASSESSMENT OF THE PISCINE MICRONU-CLEUS TEST AS AN IN SITU BIOLOGICAL INDICATOR OF CHEMICAL CONTAMINANT EFFECTS.

National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center. For primary bibliographic entry see Field 5A. W91-09994

FACTORS INFLUENCING FISH ASSEMBLAGES AND SPECIES RICHNESS IN SUBTROPICAL FLORIDA LAKES AND A COMPARISON WITH TEMPERATE LAKES.

Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences. For primary bibliographic entry see Field 2H. W91-09995

EFFECT OF TEMPERATURE ON THE CHRONIC TOXICITY OF ARSENATE TO RAINBOW TROUT (ONCORHYNCHUS MYKISS).

MYKISS), Waterloo Univ. (Ontario). Dept. of Biology. S. M. McGeachy, and D. G. Dixon. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2228-2234, November 1990. 2 fig. 4 tab, 34 ref.

Descriptors: \*Arsenic compounds, \*Fish pathology, \*Path of pollutants, Trace metals, \*Rainbow trout, \*Temperature effects, \*Toxicology, \*Water pollution effects, Arsenic, Bioaccumulation, Contamination, Exposure, Fish physiology, Lethal limit, Mortality, Tissue analysis.

Temperature plays a critical role in establishing the distribution limits, rates of function, and survival of many organisms, including fish. The effects of

water temperature (5 or 15 C) on toxicity of arsenate to rainbow trout were examined over an 11-week period. The fish were exposed to nominal arsenate concentrations set as fixed proportions of the 144 hour LC50s for arsenate at their respective temperature (5 C: 0, 1.5, 18, and 36 mg/L; 15 C: 0, 1.5, 9, and 18 mg/L). Arsenate toxicity was assessed in terms of mortality, total arsenic concentration, wet weight, condition factor, liver and muscle glycogen levels, hepatosomatic and splenosomatic indices, and histopathology. Contrary to the previously reported relationship between acute toxicity and temperature, trout were more tolerant of chronic exposure to arsenate at 15 C than 5 C. While the high exposure concentration (5 C, 36 mg/L; 15 C, 18 mg/L) fish at both temperatures attained the same internal arsenic concentration (2 to 3 microg/g), up to 50% of those fish tested at 5 C died. The whole body arsenic concentrations in moribund trout were found to vary between 4 and 6 microg/g, suggesting that a critical arsenic body concentration is reached before death or toxicant. (Author's abstract)

RELATIVE IMPORTANCE OF SEASONAL, SHORT-TERM PH DISTURBANCES DURING DISCHARGE VARIATION ON A STREAM ECOSYSTEM.

Ontario Ministry of the Environment, Dorchester. Dorset Research Center.

R. J. Hall. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2261-2274, November 1990. 9 fig, 4 tab, 63 ref.

Descriptors: "Acid rain, "Acid rain effects, "Ecosystems, "Hydrogen ion concentration, "Ontario, "Seasonal variation, "Stream biota, "Water chemistry, "Water pollution effects, Aluminum, Aquatic habitats, Dissolved organic carbon, Flow rates, Invertebrates, Iron, Manganese, Path of pollutants, Species composition, Statistical analysis, Trace metals, Zinc.

Effects of short-term, experimental pH reduction on water chemistry and structure of benthic invertebrate communities were investigated in a south-central Ontario stream during spring and fall. With increased acidity, inorganic monomeric Al and Ca concentrations were significantly increased in stream water during spring and fall, whereas Fe, Mn, and Zn concentrations did not change. Total Al and dissolved organic carbon (DOC) concentrations in stream water showed no constant pattern. Benthic density and generic richness during spring decreased in mineral, but not organic sediments. Total drift density did not change, but mayflies increased in the drift. In contrast, in the fall, benthic density and generic richness fluctuations were not correlated with pH disturbance, whereas drift density increased significantly during elevated acidity. Diversity and evenness of benthic invertebrates did not change above or below pH disturbance in either season. Non-metric multidimensional scaling analysis showed that discharge was the primary correlated of spring drift, with pH playing a secondary role. In autumn, analyses demonstrated that Ca and DOC were the predominant factors associated with increased drift, but were related to hydrology. These results highlighted the interrelationships between life history strategies of benthic invertebrates, and the frequency and intensity of physical (discharge fluctuations) and chemical (pH depressions) disturbances. (Author's abstract)

STUDIES ON MITIGATION OF THE EFFECTS OF ACIDIC PRECIPITATION ON ADULT AT-LANTIC SALMON (SALMO SALAR)-INTRO-DUCTION.

Department of Fisheries and Oceans, Halifax (Nova Scotia). Physical and Chemical Sciences Branch. For primary bibliographic entry see Field 5G. W91-10001

RESPONSES OF PLASMA ELECTROLYTES, THYROID HORMONES, AND GILL HISTOL-

OGY IN ATLANTIC SALMON (SALMO SALAR) TO ACID AND LIMED RIVER WATERS.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst. For primary bibliographic entry see Field 5G. W91-10003

MORPHOMETRIC EFFECTS OF LOW PH AND LIMED WATER ON THE GILLS OF AT-LANTIC SALMON (SALMO SALAR).

Maine Univ. at Orono. Dept. of Zoology. For primary bibliographic entry see Field 5G. W91-10004

RESPONSES OF KIDNEY, LIVER, MUSCLE, AND BONE IN ATLANTIC SALMON (SALMON SALAR) TO DIET AND LIMING IN ACIDIC NOVA SCOTIA RIVERS.
Department of Fisheries and Oceans, Winnipeg

(Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5G.
W91-10005

TOXICITY EVALUATIONS FOR HAZARDOUS WASTE SITES: AN ECOLOGICAL ASSESSMENT PERSPECTIVE,

NSI Technology Services Corp., Corvallis, OR. Environmental Research Lab. For primary bibliographic entry see Field 5E. W91-10075

SCOPE AND ASSESSMENT OF AQUATIC EFFECTS DUE TO ACIDIC DEPOSITION. FTN Associates, Little Rock, AR. K. W. Thornton, and D. K. McKenzie.

K. W. Thornton, and D. K. McKenzie. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134255. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/218, 1989. 15p, 3 fig, 1 tab. 23 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Environmental impact, \*Water pollution effects, Aquatic environment, Evaluation, Mathematical models, Model studies, Water chemistry.

The 1990 NAPAP Integrated Assessment (IA) will address the current status of surface waters in regions potentially susceptible to acidic deposition, evaluate historical changes that might have occurred in these aquatic systems and forecast future changes that might occur in these systems under current and alternative deposition scenarios. Mathematical models will be used to project future changes in surface water chemistry and fisheries responses under current and alternative levels of acidic deposition. The mathematical models include steady-state, empirical time-varying models and dynamic watershed models. Output from the chemistry models will be linked with empirical fisheries models to forecast potential changes in fish responses in these systems. Sensitivity analyses will be performed to determine the influence of different levels of acidic deposition on these projections. Uncertainty analyses will be an integral part of all analyses from current status to future forecasts. The IA will evaluate the effects of various sources of acidity on aquatic systems, including acidic deposition, and will consider the current status and extent, possible historical change and potential future changes in these systems that might be due to acidic deposition and the level of confidence that can be placed in these conclusions. (Author's abstract)

SOME EFFECTS OF A MAJOR OIL SPILL ON WINTERING SHOREBIRDS AT GRAYS HARBOR, WASHINGTON.

E. M. Larsen, and S. A. Richardson. Northwestern Naturalist: A Journal of Vertebrate Biology, Vol. 71, No. 3, p 88-92, Winter 1990. 1 fig, 19 ref.

Descriptors: \*Grays Harbor, \*Marine pollution, \*Oil spills, \*Path of pollutants, \*Washington,

# Effects Of Pollution—Group 5C

\*Water birds, \*Water pollution effects, Animal behavior, Migration, Mortality, Population density, Population dynamics.

Shorebirds wintering at Grays Harbor, Washington, were oiled when No. 6 fuel oil spilled from the barge Nestucca on December 22, 1988. Counts and observations on eight days during the ensuing two months provided information on the effects of months provided information on the effects of oiling on black-bellied plover (Pluviatilis squatarola), semipalmated plover (Charadrius semipalmatus), sanderling (Calidris alba), western sandpiper (C. mauri), and dunlin (C. alpina). Initially, 31% of shorebirds we observed roosting on ocean beaches were oiled; 10 days later this dropped to 5%. A harbor rate of 34% oiled shorebirds occurred after the ocean beach rate declined, then percentages of oiled shorebirds at each locality declined to insig-nificance. Behavioral changes were observed in official shorebirds at each focally declined to fissignificance. Behavioral changes were observed in oiled dunlins. Three alternate hypotheses may explain the disappearance of over 3500 shorebirds: self-cleaning, emigration, and mortality. (Author's

ACIDIFICATION OF THE PEDOSPHERE Natal Univ., Pietermaritzburg (South Africa).

Dept. of Agronomy. M. V. Fey, A. D. Manson, and R. Schutte. South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 403-406, July/October 1990. 4 tab,

Descriptors: \*Acid rain, \*Acid rain effects, \*Acid soils, \*Acidification, \*Land use, \*Leaching, \*Path of pollutants, \*Soil acidification, \*Soil chemistry, Afforestation, Climatic changes, Forests, Liming, Nitrogen cycle, Rainfall distribution, Sulfur cycle.

Acids accumulate naturally in soil through the processes of hydrolysis and leaching of base cations, and their distribution is closely correlated with mean annual rainfall. Acidification is greatly with mean annual rantall. Acidification is greatly intensified by anthropogenic distortions of the nitrogen and sulfur cycles, and by afforestation and the export of bases in harvested products. The rate of soil acidification is potentially highest in agriculture, associated mainly with the liberal use of ammoniacal fertilizers and the production of forage legumes. Where exotic tree species have been planted, the acidification rate is slower but a comparison of some South African data suggests that afforestation may speed up soil acidification even more than the worst recorded acid rain on the eastern Transvaal highveld. Soil sensitivity to acidification is imperfectly understood. Future research must monitor of atmospheric effects upon those chemically fragile soils which are not conveniently ameliorated by liming. Projected climatic and atmospheric changes during the next half century are unlikely to intensify greatly the acidification process. (Author's abstract) W91-10186 afforestation may speed up soil acidification even

CHANGING IMPACT OF URBANIZATION AND MINING ON THE GEOLOGICAL ENVIRONMENT.

Pretoria Univ. (South Africa). Dept. of Geology. For primary bibliographic entry see Field 4C. W91-10189

EFFECT OF ELEVATED ATMOSPHERIC CO2 ON GROWTH, PHOTOSYNTHESIS AND WATER RELATIONS OF SALT MARSH GRASS SPECIES.

Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.

J. Rozema, F. Dorel, R. Janissen, G. Lenssen, and

R. Broekman.

Aquatic Botany AQBODS, Vol. 39, No. 1/2, p 45-55, February 1991. 1 fig, 6 tab, 31 ref.

Descriptors: \*Air pollution effects, \*Global warming, \*Grasses, \*Photosynthesis, \*Plant growth, \*Plant physiology, \*Salt marshes, Carbon dioxide, Plant water potential, Salinity, Transpiration.

The C3 grass species Scirpus maritimus and Puccinellia maritima and the C4 species Spartina anglica and S. patens were grown at ambient (340 ppm

CO2) and elevated (580 ppm CO2) atmospheric CO2 concentration, at low (10 mM NaCl) and high salinity (250 mM NaCl) under aerated and anaero-bic conditions in the culture solution. The relative growth rate of both C3 species was enhanced with atmospheric CO2 enrichment; no such increase was found in the C4 species. High salinity reduced growth of the C3 species tested, but this relative growth reduction was not prevented by elevated growth reduction was not prevented by elevated CO2 concentration. The growth increase at elevated CO2 of S. maritimus and P. maritima is greater ed CO2 of S. maritimus and P. maritima is greater under aerated than under anaerobic solution conditions. Water-use efficiency of all species was increased by elevated CO2. In the case of Scirpus (C3), this increase was caused by increased net photosynthesis; for S. patens (C4) photosynthesis was not increased, but transpiration was reduced. The water potential of the shoot was less negative under conditions of CO2 enrichment, in particular at increased salinity (250 mM NaCl). (Author's abstract)

EFFECT OF CHRONIC TOXICITY OF COPPER ON THE ACTIVITY OF BALBIANI RINGS AND NUCLEOLAR ORGANIZING REGION IN THE SALIVARY GLAND CHRO-MOSOMES OF CHIRONOMUS NINEVAH

Mosul Univ. (Iraq). Dept. of Biology. J. B. Aziz, N. M. Akrawi, and G. A. Nassori. Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 125-130, 1991. 1 fig, 1 tab, 12 ref.

Descriptors: \*Copper, \*Heavy metals, \*Midges, \*Toxicity, \*Toxicology, \*Water pollution effects, Bioassay, Chromosomes, Larvae.

The effect of copper on the activity of Balbiani rings (BR1 and BR2) and nucleolar organizing region (NOR) in chromosome IV of the salivary gland of the 4th instar larvae of Chironomus ninevah was investigated. This midge species was selected as a biological indicator species because of its association with benthic secuments. Sublethal concentrations, 0.02, 0.1, 0.15, and 0.2 mg/L suppressed the activity of BR1, and were statistically similifear. The same concentrations reduced the significant. The same concentrations reduced the activity of BR2 and NOR, but without significant differences, except 0.1 mg/L, which was signifi-cant. (Sand-PTT) W91-10204

ACCELERATION OF CATALASE AND PER-OXIDASE ACTIVITIES IN LEMNA MINOR L. AND ALLIUM CEPA L. IN RESPONSE TO LOW LEVELS OF AQUATIC MERCURY.

Berhampur Univ. (India). Dept. of Botany. A. V. Subhadra, A. K. Nanda, P. K. Behera, and B. B. Panda. Environmental Pollution ENPOEK, Vol. 69, No.

2/3, p 169-179, 1991. 2 tab, 32 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Duckweed, \*Enzymes, \*Heavy metals, \*Mercury, \*Onions, \*Toxicity, \*Toxicology, \*Water pollution effects, Catalase, Organomercury compounds, Peroxidase, Plant growth, Plant physiology

Physiological responses of Lemna minor (duck-weed) and Allium cepa (onion) to aquatic Hg at low concentrations were investigated. Following a low concentrations were investigated. Following a 96-h exposure of plants to nutrient medium contaminated with known levels of HgCl2, 0.001 to 4 mg/L (0.0007 to 2.95 mg Hg/L) or methyl mercuric chloride (MeHgCl2) 0.0001 to 0.1 mg/L (0.00007 to 0.07 mg Hg/L), the physiological end-points measured were the growth of fronds (L. minor) or roots (A. cepa) and catalase and peroxidase activities in both plant assays. The ECS0 for HgCl2 on the basis of the growth curve of L. minor was 2.1 mg/L. HgCl2 and MeHgCl2 were lethal to L. minor at concentrations of 4 and 0.01 minor was 2.1 mg/L. HgCl2 and MeHgCl2 were lethal to L. minor at concentrations of 4 and 0.01 mg/L, respectively. The range of low concentrations that accelerated growth as well as enzymic activities in L. minor was 0.004 to 0.04 mg/L for HgCl2 and 0.0001 to 0.001 mg/L for MeHgCl2. HgCl2 and MeHgCl2 induced maximum enzymic activity in Lemna fronds at concentrations of 0.008 and 0.0005 mg/L, respectively. In Allium roots, catalase activity was accelerated at all the concen-

trations of HgCl2 (0.001-2 mg/L) and MeHgCl2 (0.0001-0.1 mg/L) tested. The activity of peroxidase was accelerated by HgCl2 at the concentration range 0.01-1.0 mg/L or by MeHgCl2 at 0.0005 and 0.001 mg/L. The concentrations of HgCl2 and MeHgCl2 that induced the highest enzymatic activity in Allium roots were 0.05 mg/L and 0.001 mg/L, respectively. (Author's abstract) W91-10205

BENTHIC POPULATION STUDIES OF A NORTH SEA DISPOSAL AREA USED FOR IN-DUSTRIAL LIQUID WASTE.
Imperial Chemical Industries Ltd., Brixham (Eng-

land). Group Environment Lab

N. Shillabeer. Environmental Pollution ENPOEK, Vol. 69, No. 2/3, p 181-191, 1991. 3 fig, 3 tab, 18 ref.

Descriptors: \*Benthic fauna, \*Chemical wastes, \*England, \*Industrial wastes, \*Liquid wastes, \*Wastewater disposal, \*Water pollution effects, Marine sediments, Population dynamics, Species diversity, Teesside

The by-product acid resulting from the production of methyl methacrylate at Teesside (NE England) is discharged to a liquid waste disposal site. A 5-year study of benthic infaunal populations of both the disposal and a control area has not demonstrated any effect that may be related to the waste disposal. This result was anticipated, as hydrographic studies of waste dilution have shown acute toxic effects are limited to the immediate wake of the waste tanker and that there is no risk of effluent accumulating in the area. K dominance plots of both control and disposal area stations showed a limited number of stations with a fauna dominated by a single species, Amphiura filiformis. However, it seems unlikely that this dominance is related to the waste disposal. Multi-variate techniques used to analyze the data have indicated no niques used to analyze the data have indicated no evidence of a decline in the abundance or diversity of the benthic fauna in the study areas. The distribution of the fauna appears to be related to sediment particle size distribution. (Sand-PTT) W91-10206

EFFECT OF TEMPERATURE, SEASON, AND FISH SIZE ON ACUTE LETHALITY OF SUSPENDED SEDIMENTS TO COHO SALMON (ONCORHYNCHUS KISUTCH).

Department of Fisheries and Oceans, Cultus Lake (British Columbia). Cultus Lake Salmon Research

For primary bibliographic entry see Field 2H.

EFFECT OF ENVIRONMENTAL PH ON THE HEPATIC MIXED FUNCTION OXIDASES IN ATLANTIC SALMON (SALMO SALAR).

Bedford Inst. of Oceanography, Dartmouth (Nova

D. E. Willis, A. J. Edwards, and R. F. Addison. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 48, No. 3, p 445-447, March 1991. 1 tab, 22 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Fish physiology, \*Liver enzymes, \*Metabolism, \*Salmon, Aquatic habitats, Canada, Hydrogen ion concentration, Medway River, Nova Scotia, West-

Atlantic salmon were held for several months in the Medway River, Nova Scotia, at pH 5.2-5.5 and in the Westfield River in either untreated (acidic) water at pH 4.7-5.2 or limed water at pH 5.1-5.9 and were examined for effects on hepatic monoox-ygenases. Fish from the Westfield acidic regime ygenases. Fish from the Westlield acidic regime had lower body weights than those from the other two regimes, but similar liver weights. Females generally had higher hepatic microsomal protein contents than males, but this variable was not affected by environmental pH. Westlield acidic fish usually had higher benzo(a)pyrene hydroxylase and lower ethoxyresorufin O-deethylase activity than those from the other two regimes. Cytoch. ity than those from the other two regimes. Cytochromes P450 and b5 showed no clear difference

### Group 5C-Effects Of Pollution

between groups. Although the different pH environments affected reproductive success and steroid hormone metabolism, such changes were not reflected in these components of the hepatic monooxygenase system. (Author's abstract) W91-10225

ADRENERGIC RESPONSE TO PHYSIOLOGI-CAL DISTURBANCES IN RAINBOW TROUT, ONCORHYNCHUS MYKISS, EXPOSED TO ALUMINUM AT ACID PH.

Centre d'Etude de l'Energie Nucleaire, Mol (Belgium). Lab. for Mineral Metabolism. H. E. Witters, S. Van Puymbroek, and O. L. J.

Vanderborght.
Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 48, No. 3, p 414-420, March 1991. 2 fig, 2 tab, 46 ref. Commission of the European Communities Contract No. EV4V-0116B

Descriptors: \*Acid rain effects, \*Acidic water, \*Aluminum, \*Fish physiology, \*Toxicity, \*Trout, \*Water pollution effects, Aquatic habitats, Blood, Catecholamines, Hemoglobin, Hormones, Hydrogen ion concentration, Hypoxia, Oxygen carrying conscits, Sedium capacity, Sodium.

A 10-fold increase of plasma epinephrine and nore-pinephrine levels was evident at 46 h of Al expo-sure in adult rainbow trout, Oncorhynchus mykiss, which were kept for about 2.5 d at pH 5.0 with 60 microgram Al/L (Ca = 20 micromol/L). The change of plasma epinephrine levels was related both to the decrease of the blood pH and the decrease of the blood oxygen tension. Decreased plasma Na concentrations were also observed, which were accompanied by elevated levels of cortisol in the plasma of Al-exposed fish. Exposure of fish to pH 6.8 (= control) or pH 5.0 without Al did not yield any changes in plasma Na, plasma cortisol, blood pH, blood oxygen tension, and plasma epinephrine, norepinephrine, and dopamine levels. The release of plasma catecholamines associated with blood acidosis and hypoxia may be an important factor in maintaining erythrocytic pH to protect the hemoglobin oxygen carrying capacity in fish exposed to low pH and Al. (Author's ab-

ACID PRECIPITATION STUDIES IN COLO-RADO AND WYOMING: INTERIM REPORT OF SURVEYS OF MONTANE AMPHIBIANS

AND WATER CHEMISTRY.
National Ecology Research Center, Fort Collins,

Co.
P. S. Corn, W. Stolzenburg, and R. B. Bury.
Available from the National Technical Information
Service, Springfield, VA. 22161, as PB90-103300.
Price codes: A04 in paper copy, A01 in microfiche.
Fish and Wildlife Service Biological Report
80(40.26), June 1989. 56p, 13 fig. 5 tab, 77 ref, 7
append. Forest Service and National Park Service
Interagency Agreement IAG-RM-6-97.

Descriptors: \*Acid rain, \*Acid rain effects, \*Alpine regions, \*Amphibians, \*Hydrogen ion concentration, \*Water pollution effects, Aluminum, Colorado, Embryos, Frogs, Lethal limit, Mountain lakes, Mountain watersheds, Salamanders, Toads, Wyoming.

Surveys for amphibians were conducted in the Rocky Mountains of northern Colorado and south-ern Wyoming from 1986 to 1988. The northern ern Wyoming from 1986 to 1988. The northern leopard frog (Rana pipiens) was present at only 12% of historically known localities, and the boreal toad (Bufo boreas) was present at 17% of known localities. Chorus frogs (Pseudacris triseriata) suffered a catastrophic decline in population size in one population monitored since 1961, but regionally, this species was observed in 64% of known localities. Tiger salamanders (Ambystoma tigrinum) and wood frogs (Rana sylvatica) were present at 45% and 69% of known localities. Acid neutralizing capacity, pH, specific conductivity, and cation concentrations in water at amphibian localities were negatively correlated with elevalocalities were negatively correlated with elevation. However, in mountain ponds and lakes, pH was rarely < 6.0 during the amphibian breeding season. In laboratory tests of the tolerance of em-

bryos to acid, the LC50 pH was 4.8 for chorus frogs, 4.4-4.7 for leopard frogs, 4.4-4.5 for boreal toads, and 4.2-4.3 for wood frogs. Survival of wood frog embryos declined when exposed to aluminum concentrations of 100 microgm/L or greater, but boreal toad embryos survived expo-sure to aluminum concentrations of 400 microgm/ L. (Author's abstract) W91-10240

HAZARDOUS WASTE SITE CHARACTERIZA-TION UTILIZING IN SITU AND LABORATORY BIOASSESSMENT METHODS. Corvallis Environmental Research Lab., OR. For primary bibliographic entry see Field 5A. W91-10258

INTRAUTERINE EXPOSURE TO ENVIRON-MENTAL TOXINS: THE SIGNIFICANCE OF SUBTLE BEHAVIORAL EFFECTS

Wayne State Univ., Detroit, MI.
J. L. Jacobson, S. W. Jacobson, and G. G. Fein.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-134479. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/235, 1985. 15 p, 2 tab, 26 ref. EPA Grant R808520010.

Descriptors: \*Behavior, \*Intrauterine exposure, \*Path of pollutants, \*Polychlorinated biphenyls, \*Public health, \*Toxicity, \*Water pollution effects, Biochemistry, Fish, Food chains, Lake Michigan, Newborns, Organic compounds, Statistical analy-

Recently, there has been an increase in interest in subtle effects associated with exposure to environmental toxins. One methodological problem in research in this area involves assessment of degree of contamination when exposure occurs at low and moderate levels. A second problem lies in deter-mining the clinical or practical significance of subtle toxic effects when they are observed. Both these issues are illustrated by the case of polychlorinated biphenyls (PCBs), a family of environmental toxins found in moderate concentrations in humans who consume Lake Michigan sports fish. Two hundred forty-two newborns whose mothers had consumed these fish and 71 newborns whose mothers had abstained were examined in the immediate post-partum period. Degree of exposure was measured by both maternal contaminated fish con-sumption and cord serum PCB level. An examination of the data suggests that, at the levels of exposure found in this sample, a maternal report may in some instances be more sensitive and reli-able than a biochemical analysis. While statistically significant effects on birth size, gestational age, and neonatal behavior were observed, the clinical significance of these effects is not yet known since none of the exposed infants weighted < 1500 gm and criteria for newborn behavioral adequacy have not been established. However, research on other toxic substances suggests that subtle neonatal deficits frequently signal the existence of an ongoing toxic process with clinically significant implications for later development. (Author's abstract) W91-10264 and criteria for newborn behavioral adequacy have

KINETICS OF CHEMICAL WEATHERING: COMPARISON OF LABORATORY AND FIELD WEATHERING RATES,

Iowa Univ., Iowa City. Dept. of Civil and Envi-ronmental Engineering.

ronmental Engineering.
J. L. Schnoor.
IN: Aquatic Chemical Kinetics: Reaction Rates of Processes in Natural Waters. Environmental Science and Technology Series. John Wiley & Sons, New York. 1990. p 475-504. 18 fig, 3 tab, 36 ref.

Descriptors: \*Acid rain effects, \*Aluminum, \*Chemical degradation, \*Geochemistry, \*Kinetics, \*Minerals, \*Weathering, Hydrogen ion concentration, Ion exchange, Maine, Silicates, Soil properties. ties, Surface processes

Aluminosilicate minerals undergo surface-controlled dissolution reactions that are fractional order with respect to bulk H(+) ion concentration in solution. Kinetics of chemical weathering can be

explained by surface coordination chemistry, where the detachment of an activated complex is the rate-determining step in dissolution. Dissoluthe rate-determining step in dissolution. Dissolu-tion reactions may occur incongruently at first, but eventually the build-up of a cation-depleted solid layer will provide for stoichiometric mineral weathering. Protons and organic ligands may ac-celerate the rate of mineral weathering. Results of a field study at Bear Brook Watershed, Maine, were compared with laboratory kinetic experi-ments using size-fractionated soils from the same location. The watershed is a forested, glaciated region with thin podzolic soils and granitic gneiss bedrock. Fractional order dependence of weatherbedrock. Fractional order dependence of weatherbedrock. Fractional order dependence of weather-ing rates on H(+) ion-activity were demonstrated for batch pH-stat experiments of B-horizon soils in the pH range 2.7-4.0. The soils tested were rich in aluminum, and B-horizon samples yielded high concentrations of dissolved aluminum (0.2-1.0 mil-limoles/L) during the first 50 hr of reaction. This was attributed to ion exchange and a rapid dissolu-tion of amorphous aluminum hydroxide. As a result of the initial rapid reaction, H(+) ion con-sumption and release rates of other solutes (Si, Al. Ca, Mg. Na) were asymptotic with time. Release Ca, Mg, Na) were asymptotic with time. Release rates of ions became constant after 200 hr, and weathering rates were determined in the range 200-400 hr. Flow-through column experiments were also run on the same soils. Soil column results provided the best simulation of field conditions with pH 4 influent (sulfuric acid), and the effluent resulted in a pH of 5.8, similar to Bear Brook. A comparison of laboratory weathering rates and estimates from the field indicated that laboratory rates were one to two orders of magnitude greater than field estimates of chemical weathering. Based on dissolved silica as a conservative tracer of weathering, laboratory rates were on the order of 1 to 10 picomoles/sq m/sec, while field weathering rates were .01 to 1 picomoles/sq m/sec. The discrepancy is likely due to the difficulty of estimating a suitable wetted surface area of weatherable (reacting) minerals in the field, and the possibility of hydrologic control, due to macropore flow through soils. (See also W91-10309) (Geiger-PTT) W91-10326

HEALTH EFFECTS OF AGRICHEMICALS IN GROUNDWATER: WHAT DO WE KNOW

National Cancer Inst., Bethesda, MD. Environ-mental Epidemiology Branch.

K. P. Cantor, A. Blair, and S. Hoar Zahm. IN: Agricultural Chemicals and Groundwater Pro-tection: Emerging Management and Policy. Pro-ceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 27-42. 50 ref.

Descriptors: \*Agricultural chemicals, \*Drinking water, \*Fertilizers, \*Groundwater pollution, \*Ni-trates, \*Pesticides, \*Water pollution effects, Carcinogenicity, Epidemiology, Human diseases, Literature review, Population exposure, Public health, Risk assessment.

The health effects associated with exposure to agricultural chemicals are reviewed. Drinking water has been implicated as an important route of exposure for nitrate, and is becoming more impor-tant in pesticide exposure as groundwater contami-nation increases. High nitrate in drinking water can nation increases. High nitrate in drinking water can cause methemoglobinemia, a potentially lethal con-dition of early infancy that impairs hemoglobin's ability to carry oxygen. Nitrate, when reduced to nitrite in saliva, can combine with secondary amines from dietary or other sources to form highly carcinogenic N-nitroso compounds. Al-though human cancer from this source has not here documented there is concern that consume been documented, there is concern that consump tion of water with high nitrate levels places posed persons at risk, especially in conjunction with exposure to chemicals with secondary amine structures, such as some pesticides. Occupational studies of workers exposed to pesticides suggest that some insecticides and herbicides are human carcinogens. Studies of lung cancer among pesti-cide applicators and hematopoietic cancers such as elukemia, non-Hodgkin's lymphoma, and multiple myeloma among farmers suggest that these malig-nancies are linked to a range of agricultural chemi-cals. Although pesticide levels in most groundwat-

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Effects Of Pollution-Group 5C

er sources may be too low to result in carcinogenic effects detectable on an epidemiologic scale, risks to the general population are of concern, given the large number of exposed individuals. Other effects, such as impaired immune function and adverse birth outcomes, have received some attention and are the focus of further research. (See also W91-10488) (Author's abstract) W91-10390

# POLLUTION: CAUSES, EFFECTS AND CONTROL.

For primary bibliographic entry see Field 5B. W91-10406

WATER QUALITY AND HEALTH.
R. F. Packham.
IN: Pollution: Causes, Effects and Control. Royal
Society of Chemistry, Cambridge, England. 1990.
p 83-97, 2 fig, 4 tab.

Descriptors: \*Drinking water, \*England, \*Public health, \*Water pollution effects, \*Water treatment, Aluminum, Asbestos, Fluoride, Cancer, Chronic toxicity, Disinfection, Lead, Nitrates, Organic compounds, Sodium, Toxicity, Water distribution.

Concern about possible health effects of chemicals in drinking water stemmed from the application of sophisticated analytical techniques which revealed the presence of traces of many potentially harmful chemicals. The significance to health of these was uncertain although some would undoubtedly cause uncertain attnough some would undoubreuty cause concern were they present at much higher concen-trations. Fear about the possibility of health effects was reinforced by evidence that environmental factors which could conceivably include drinking water quality are involved in many chronic dis-eases such as cardiovascular disease and cancer. A eases such as Carlovascular disease and cancer. A study was made of the following aspects of drink-ing water in England: lead, nitrate, water quality and cardiovascular disease, organic micropollu-tants, wastewater re-use and health, organic compounds and disinfection, organic contamination of drinking water in distribution systems, aluminum, asbestos, fluoride and sodium. There is only very limited evidence that chemical constituents of drinking water are involved in health problems. Any health effects of such materials are likely to result from long-term exposure and unless this leads to an extremely unusual disease the effect is likely to be very difficult to detect. (See also W91-10405) (White-Reimer-PTT) W91-10411

# BIOLOGICAL ASPECTS OF FRESHWATER POLLUTION. Essex Univ., Colchester (England). Dept. of Biol-

ogy. C. F. Mason.

C. F. Mason.
In: Pollution: Causes, Effects and Control. Royal
Society of Chemistry, Cambridge, England. 1990.
p 99-125, 10 fig, 2 tab.

Descriptors: \*Ecological effects, \*England, \*Wales, \*Water pollution effects, Acidification, Agricultural runoff, Effluents, Eutrophication, Or-ganic pollutants, Path of pollutants, Thermal pollution, Toxicity.

Organic pollution results when large quantities of organic matter are discharged into a watercourse and broken down by oxygen-utilizing microorganisms, to the detriment of the stream biota. The misms, to the detriment of the stream blota. Ine addition of nutrients to a body of water from this breakdown of organic matter—or from the increas-ing use of phosphorus-containing detergents (much of this entering the river in sewage effluent), the runoff of artificial fertilizers from farms and manure from feedlots, the burning of fossil fuels which increases the nitrogen content of rain, or the felling of forests which causes increased erosion and runoff--stimulates the growth of aquatic plants and is known as eutrophication. Acid rain and acidification of fresh waters results in the simplifiactunication of irest waters results in the simplifi-cation of aquatic ecosystems and loss of fish popu-lations. The effects of toxic chemicals may be (1) acute (causing an effect, usually death, within a short period); (2) chronic (causing an effect, lethal or sublethal, over a prolonged period of time); (3)

lethal (causing death by direct poisoning); (4) sub-lethal (below the level which causes death but affecting growth, reproduction, or behavior so that the population may eventually be reduced); or (5) cumulative (increasing in effect over successive doses). Thermal pollution, such as cooling-water discharges from electricity-generating stations, can cause an increase in water temperature which electric the physical environment in screen of both cause an increase in water temperature which alters the physical environment, in terms of both a reduction in the density of the water and its oxygen concentration, while causing an increase in the metabolism of organisms. Regional surveys have given every indication that water quality in England and Wales has declined sharply since 1980 due to deterioration in the quality of sewage effluents and to increased farm pollution, severely affecting many previously unpolluted rivers in rural areas. (See also W91-10406) (White-Reimer-PTT) W91-10412

EFFECTS OF GASEOUS POLLUTANTS ON CROPS AND TREES.

CROPS AND TREES.
Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.
T. A. Mansfield, and P. W. Lucas.
IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 237-259, 9 fig, 1 tab.

Descriptors: \*Acid rain effects, \*Air pollution, \*Air pollution effects, \*Crops, \*Trees, \*Vegetation effects, Air pollution control, Nitrogen oxides, Ozone, Photosynthesis, Plant physiology, Sulfur

In the last two decades, emission control legisla-tion, increased urbanization, and new abatement technologies, such as the shift to the use of tall stacks in power stations, have resulted in changes in the quantity and quality of atmospheric pollut-ants. In addition to a gradual shift in research from herbaceous plants to trees, more information is currently available on the distribution of pollutants in the atmosphere and this has led to more interest in the combined action of pollutants. Exchanges of carbon dioxide and water vapor between plants and the atmosphere are fundamental to many physiological processes such as photosynthesis, respira-tion, and transpiration carried out by plants. The tion, and transpiration carried out by plants. The exchange of gases with the atmosphere is regulated by opening and closing of stomata, and the uptake of pollutants, such as SO2, is also thought to occur primarily via these pores at the surface of the leaf. Other pollutants that affect plants include nitrogenous compounds, ozone, and acid rain. Interactions between pollutants that are currently being studied are mixtures of SO2 and NO2, and SO2 and O3. In addition, evidence from a few experiments suspess addition, evidence from a few experiments suggest that stress factors, biotic and abiotic are also factors to consider when evaluating pollution effects. (See also W91-10406) (White-Reimer-PTT) W91-10416

### HEALTH EFFECTS OF ENVIRONMENTAL

Saint Mary's Hospital Medical School, London (England). H. A. Waldron.

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990.

p 261-276.

Descriptors: \*Air pollution effects, \*Chemical wastes, \*Population exposure, \*Public health, \*Toxic wastes, \*Water pollution effects, Accidents, Attitudes, Environmental quality, Mortality, Public opinion, Safety.

There has been, and continues to be, a good deal of public concern about the effects which the release public concern about the elected which the recease of chemicals into the environment may have on health. Implicit in this concern, and frequently explicit, is the idea that any effects will necessarily be adverse, although human life is not possible in the absence of chemicals, both organic and inorthe assence of chemicus, both organic and mor-ganic. Different types of exposure to environmen-tal chemicals may be distinguished: (1) catastrophic exposure which results from the massive release of material into the environment; (2) endemic expo-sure which occurs when very large numbers of

people are exposed, usually as the result of misuse of chemicals; and (3) concomitant exposure which is inescapable in a society that depends on the use of chemicals to maintain life. Catastrophic and endemic exposure undoubtedly cause much human suffering and may be associated with a considerable mortality and morbidity. Accidents which lead to catastrophic exposure are unpredictable, but steps can be taken to minimize the likelihood of their occurrence. Endemic exposure is the most serious of all forms of environmental exposure, and it is not easily controlled since it is the result of deliberate acts rather than accidents. Concomitant exposure, the lowest in ranking order, evokes the greatest alarm in the general population and may give rise to fear about consequences which are insignificant compared with other effects. (See also W91-10406) (White-Reimer-PTT) W91-10417

### PESTICIDES AND GROUNDWATER: HEALTH CONCERN FOR THE MIDWEST.

For primary bibliographic entry see Field 5G.

#### HEALTH EFFECTS FROM GROUNDWATER PESTICIDES.

Illinois Univ. at the Medical Center, Chicago. Coll. of Medicine.

M. A. Evans.

IN: Pesticides and Groundwater: A Health Con-In: Pesticiaes and Groundwater: A Health Con-cern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 45-80. 9 tab, 79 ref.

Descriptors: \*Agricultural chemicals, \*Ground-water pollution, \*Pesticides, \*Public health, \*Tox-icity, \*Water pollution effects, Carcinogens, Epi-demiology, Nitrates, Nitrites, Population exposure,

The health effects of pesticides in groundwater are assessed by acute and chronic toxicity studies in assessed by active and clinic toxicity studies in experimental animals, and data from cases of acci-dental ingestion, clinical exposures, and occupa-tional exposures. Pesticides which have been linked with increased cancer risk include aminotriazole, amitrole, arsenicals, cabaryl, chlorophen-oxy compounds, diallate, ethylene dibromide, ethylenethiourea, maneb, nitrofen, sulfallate, zectran, and a number of organochlorine pesticides. Although not directly toxic, nitrates in the presence of microorganisms in the soil, water, sewage, and alimentary tract are converted to nitrites. Acute exposure to high levels of nitrites is associated with methemoglobinemia, with particular susceptibility in the newborn. A chronic health hazard associated with ingestion of large concentrations of nitrites is the possible formation of carcinogenic N-nitroso compounds. Epidemiological studies have indicat-ed a possible association between exposure to high levels of nitrate and nitrite and a high incidence of stomach and esophageal cancer. Allergic-type reactions are the most common immunological disor-ders of humans and animals exposed to pesticides, although the concentrations of pesticides found in groundwater would not be expected to produce an allergic response in most cases. Autoimmune re-sponses have also been associated with pesticide exposure. Other recent concerns involving the immune system and pesticide exposure have been focused on the possible implication of immune suppression in neoplastic diseases. The major factors which determine pregnancy outcome follow-ing exposure to pesticides include time of exposure, ing exposure to pesticides include time of exposure, exposure level, and individual genetic factors. Although a number of pesticides are suspected human teratogens based on their reported cytotoxicity and results from animal reproductive studies, no confirmed relationship, aside from methyl mercury, has been established between pesticide exposure and human teratology. Although no clear association has been demonstrated between exposure to low levels of pesticides in groundwater and adverse health effects, it is recommended that seriadverse health effects, it is recommended that seri-ous consideration be given to potential adverse health effects from groundwater contaminants, in-

### **Group 5C—Effects Of Pollution**

cluding pesticides. (See also W91-10423) (MacKeen-PTT) W91-10426

HEALTH CONCERNS AND CHRONIC EXPO-SURES TO PESTICIDES: ASSESSING THE RISK FROM CARCINOGENS.

Cincinnati Univ. Medical Center, OH. Dept. of Environmental Health. R. E. Albert.

R. E. Albert.

In: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 163-168.

Descriptors: \*Carcinogens, \*Pesticides, \*Popula-tion exposure, \*Public health, \*Risk assessment, \*Water pollution effects, Administrative agencies, Administrative regulations, Animal pathology, Chronic exposure, Epidemiology, Human patholo-

Risk assessment of potential carcinogens was addressed by EPA in 1976 in guidelines having two components, qualitative and quantitative. The qualitative aspect of risk assessment addresses the question of how likely a given agent is to be a human carcinogen, based upon the weight of evidence in human and animal systems. The quantitative side of risk assessment utilizes the linear non-threshold dose-response model taken from the field of ionizing radiation to estimate the risk at very low dose-response model taken from the field of ionizing radiation to estimate the risk at very low
concentrations of carcinogen. The concentrations
of concern in the regulation of environmental carcinogens are at least a thousand times lower than
the minimal detectable response in animals or, in
most cases, observable human responses. The basic
tenets of risk assessment have not changed since
1976. The 1986 EPA guidelines for risk assessment
have formally adopted what had been an exploratory approach to grading the weight of evidence tory approach to grading the weight of evidence for carcinogenicity. The development of methodology to express the uncertainties of risk assessment is recommended in the 1986 guidelines. (See also W91-10423) (MacKeen-PTT)

### CANCER AND PESTICIDES AMONG FARM-

National Cancer Inst., Bethesda, MD, Environ-

mental Epidemiology Branch.

A. Blair, K. Cantor, S. Zahm, L. Burmeister, and

S. Van Lier.

IN: Pesticides and Groundwater: A Health Conoren for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 169-197. 17 tab, 15 ref.

Descriptors: \*Cancer, \*Epidemiology, \*Farmers, \*Pesticides, \*Population exposure, \*Risk assessment, Agricultural chemicals, Human pathology, Human population, Iowa, Kansas, Minnesota.

Increased risks of cancer among farmers, particularly cancer of the lymphatic and hematopoietic system, have been noted in geographic studies of mortality patterns, broad occupational surveys, and death certificate case-control studies. Farmers are of interest because they come in contact with a variety of potentially hazardous substances including pesticides. From death certificate studies, relative risks have been particularly high among farmers born more recently and dying at younger ages which suggests that factors associated with modern agriculture may be involved. Farmers residing in counties where corn production and pesticide use were more prevalent were also at higher risk than were more prevaent were also at ingner risk man other farmers. To follow up leads from these death certificate studies, the National Cancer Institute in collaboration with the University of Iowa, Univer-sity of Minnesota, and University of Kansas conducted population-based case-control studies of leukemia, lymphoma, and soft-tissue sarcoma. Results from these studies conflict regarding risks for farmers overall. There was a slight risk of non-Hodgkin's lymphoma (40% excess) in Kansas, but not in Iowa/Minnesota. Both studies, however, indicate that farmers exposed to specific pesticides have significantly elevated risks for non-Hodgkin's lymphoma, and the Iowa/Minnesota study showed an increased risk for chronic lymphatic leukemia. (See also W91-10423) (Author's abstract) W91-10432

# CHRONIC EXPOSURE TO ALDICARB CONTAMINATED GROUNDWATER AND HUMAN IMMUNE FUNCTION.

M. Fiore.

In: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 199-203.

Descriptors: \*Aldicarb, \*Groundwater pollution, \*Human physiology, \*Pesticides, \*Population exposure, \*Water pollution effects, Epidemiology, Immune function, Public health, Toxicity, Water quality standards, Wisconsin.

The effects of chronic exposure to aldicarb-contaminated groundwater on human immune func-tion were studied by cross-sectional epidemiological study of exposed and unexposed residents of Portage County, Wisconsin. Laboratory analysis of well water samples collected during the study indi-cated that 23 of the 50 women enrolled in the study drank water with detectable levels of aldistudy drank water with detectable levels of addi-carb (exposed group) and 27 women drank well water with non-detectable aldicarb (unexposed group). The mean aldicarb level among the 23 exposed subjects was 16.1 ppb, ranging from 1 to 61 ppb. No statistically significant differences were noted between exposed and unexposed groups in complete blood count measures, quantitative immunoglobulin, B-cell subsets, or antibody response to tetanus toxoid booster. However, in meas T-cell subsets, exposed and unexposed women did differ significantly. Exposed subjects tended to have an increase in the absolute number and percentage of lymphocytes as T8 cells and a concomitant decrease in the T4:T8 ratio. The alteration in T-cell subsets was not accompanied by any obvi-ous present clinical implications. The results suggest that aldicarb-contaminated groundwater may act as a lymphocyte stimulant, resulting in T4:T8 act as a lymphocyte stimulant, resulting in 14:18 ratios that were, in some instances, outside the range of clinical normality. In response to these and other data, the Wisconsin Division of Health has lowered its health advisory for aldicarb contaminated groundwater from 10 ppb to 1 ppb. (See also W91-10423) (MacKeen-PTT)
W91-10433

#### DBCP AND DRINKING WATER IN CALIFOR-

Hazard Evaluation Section, 2151 Berkeley Way, Berkeley, CA 94704. R. J. Jackson.

IN: Pesticides and Groundwater: A Health Con-In: Pesticutes and Oroundwater: A relatif Con-cern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 205-210. 7 ref.

Descriptors: \*California, \*Carcinogens, \*Dibromo-chloropropane, \*Drinking water, \*Pesticides, \*Water pollution, \*Water pollution effects, Cancer, Epidemiology, Human pathology, Popula-tion exposure, Public health, Water quality stand-ards

Health risks of 1,2-dibromo-3-chloropropane (DBCP) in California drinking water are discussed. DBCP, a nematocide, was first used in California DBCP, a nematocide, was first used in California in the 1950s and its use peaked at about one million pounds per year in the 1970s. The incidence of male infertility among workers at a pesticide formulation facility, coupled with the discovery of DBCP in drinking water, led to a DBCP ban in California in 1977. A epidemiological study of cancer rates in Fresno County populations having low, medium, or high DBCP exposure was performed. Rates of death from six cancers were examined on 1219 death extrifects for the study. examined on 1219 death certificates for the study years 1970-1979. For four of the cancers, there was

no association between trends of increasing DBCP in the census tract and increasing rates of death by cancer. But for stomach cancer, in both males and females and for both sexes combined, there was a progressive increase as one went from low to high DBCP census tracts. In earlier animal studies, stomach cancer was observed when DBCP was administered by gavage or skin painting. Exposed populations also had statistically significant trends of excess leukemia. The findings, while resulting in a public controversy, triggered the development of further action levels and Maximum Contaminant Levels for drinking water and legislation which mandated targeted sampling of groundwater throughout the state. Establishment and extension of the California Birth Defects Monitoring Program into the Central Valley were also recommended. (See also W91-10423) (MacKeen-PTT) stomach cancer was observed when DBCP was W91-10434

# NEW METHOD FOR ASSESSING HUMAN HEALTH RISKS FROM CHEMICAL EXPO-

Duke Univ. Medical Center, Durham, NC. Lab. of Environmental Pharmacology and Toxicology.
R. J. Francovitch, and D. B. Menzel.

IN: Pesticides and Groundwater: A Health Conoren for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 253-273. 9 fig, 22 ref. NIH Grants ES01859, ES07031, CA14236, and RR01693.

Descriptors: \*Air pollution effects, \*Model studies, \*Population exposure, \*Public health, \*Risk assessment, \*Water pollution effects, Carcinogens, Human physiology, Methylene chloride, Nickel, Pharmokinetics, Toxicology, Water quality standards

Physiologically based pharmokinetic (PB-PK) modeling is a new mathematical procedure designed to increase the accuracy of assessing health signed to increase the accuracy of assessing health risks posed by chemical exposure. The technique uses basic anatomical, physiological, and biochemical information, specific for animal species and chemical under investigation, to make predictions of toxicant concentrations in target tissues. PB-PK models can be solved on computers and are particularly useful for estimating human health risks from animal toxicity data. PB-PK models were used to study the carcinogenic and toxic chemicals nickel and methylene chloride. A model for the deposition and clearance of soluble nickel aerosols in the lung illustrates how toxic hazards in the air can be estimated. This model, developed using kinetic data collected from inhalation exposure studies in rats, can simulate human exposure from occupational, urban air, and cigarette smoking situations. The current occupational safety level is likely to be two or three times too high for reasonable risk according to the model. A model describ-ing the disposition of methylene chloride has been constructed to estimate target tissue concentrations of toxic metabolites of this volatile organic chemical. The methylene chloride model differs substantially from the methods currently in use for risk nany from the methods currently in use for risk assessment to predict target tissue doses of chemicals. Predicted target tissue doses were as much as 212 times lower than those values estimated by present methods, mainly because chemicals are not metabolized by the body in a linear manner. While most PB-PK models have dealt with cancer risks, the method is very useful in predicting other health. the method is very useful in predicting other health risks such as birth defects, neurological impair-ment, and chronic diseases. PB-PK models can be used for all classes of chemicals including pesti-cides and herbicides. The method can be used to improve the confidence in government regulations by removing controversy and building consensus. (See also W91-10423) (Author's abstract) W91-10437

#### CANCER AND BIRTH DEFECT REGISTRIES: A MANAGEMENT TOOL IN IOWA.

Iowa Univ., Iowa City. Coll. of Medicine.

### Waste Treatment Processes—Group 5D

P. Isacson.
IN: Pesticides and Groundwater: A Health Con-In: Pesticiaes and Groundwater: A Health Con-cern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 293-297. 1 tab, 2 ref.

Descriptors: \*Carcinogenicity, \*Groundwater pol-lution, \*Iowa, \*Public health, \*Teratogenicity, \*Water pollution effects, Drinking water, Epidemi-ology, Human population, Pathology, Pesticides, Population exposure.

Two basic types of cancer and birth defect registries used in evaluating the human health hazards from pesticides in groundwater are 'exposure registries', which collect information on persons known to be exposed to the potential hazard, and 'outcome registries', which record disease occurrence. Limitations of registry analyses include lack of information on other risk factors and length of exposure, and misclassification of case data with regard to precise location. Requesting additional information by mail from cancer cases has been information by mail from cancer cases has been useful in overcoming some of the limitations. Outcome registries amy provide useful data for preliminary investigations of the relationship between pesticides in groundwater drinking supplies and adverse health outcomes. Their value will not lie establishing conclusive evidence, but rath justifying the time and expense of more definitive case-control or cohort studies. In Iowa, cancer registry studies indicated an association between incidence rates of colorectal, lung, and bladder incidence rates of colorectas, lung, and oladder cancers and indications of contamination of the municipal water supply. The optimal registry is a population-based incidence registry in a broad ag-ricultural geographic area in which pertinent data on pesticide exposure and other disease-related variables can be obtained. (See also W91-10423) (MacKeen-PTT) W91-10440

### 5D. Waste Treatment Processes

DETERMINATION OF TOTAL METALS IN SEWAGE SLUDGES BY ION CHROMATOG-

Iowa State Univ., Ames. Dept. of Agronomy. For primary bibliographic entry see Field 5A. W91-09336

HYDRAULIC CONDUCTIVITY AND NITROGEN REMOVAL IN AN ARTIFICIAL WETLAND SYSTEM.

LAND SYSTEM. Cornell Univ., Ithaca, NY. Dept. of Agronomy. B. D. McIntyre, and S. J. Riha. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 259-263, January/March 1991. 2 fig, 2 tab. 16 ref

Descriptors: \*Artificial wetland treatment, \*Artifi-cial wetlands, \*Hydraulic conductivity, \*Nitrogen removal, \*Wastewater treatment, \*Wetland treat-ment, Ammonia, Aquatic plants, Bulrushes, Cat-tails, Nitrates, Nitrogen compounds, Porous media, Root zone, Sand, Wetland wastewater treatment,

A greenhouse study using aquatic macrophytes rooted in sand was conducted to test if the presence of below ground plant material increases or maintains permeability in horizontal subsurface flow systems constructed for wastewater treatment. Nutrient solutions low in suspended solids (SS) and biochemical oxygen demand (BOD) were substituted for actual wastewater. Three batch applications of NH4-N and three of NO3-N were plications of NH4-N and three of NO3-N were added for 48 hr periods at concentrations of approximately 20, 55, and 80 mg/L to assess the ability of these systems to remove N. Saturated hydraulic conductivity, Ks, was monitored over 236 d in boxes of sand planted with two different aquatic macrophytes: Typha glauca (cattail) and Scirpus acutus (bulrush). The Ks decreased over time in the vegetated and nonvegetated (control) systems. The decrease was significantly greater in the vegetated systems (55%) than in the control (41%), which was attributable to the settling of the

sand. Despite these decreases, Ks at the end of the study was still high (0.62 cm/s) even in the vege-tated systems. The vegetative systems were signifitated systems. The vegetative systems were signifi-cantly more effective than the non-vegetated at removal of NH4-N and NO3-N. No significant removal of NH4-N and NO3-N. No significant difference was noted in the N removal efficiency of the two plant species. These results suggest that artificial wetlands using sand can be used to remove N from wastewater, but decreased soil permeability may occur. (Author's abstract) W91-09355

DEVELOPMENTS IN WASTEWATER TREAT-MENT FOR NUTRIENT REMOVAL. Technical Univ. of Denmark, Lyngby. Dept. of Environmental Engineering. P. Harremoes, E. Bundgaard, and M. Henze. European Water Pollution Control, Vol. 1, No. 1, p 19-23, January 1991. 9 fig, 7 ref.

Descriptors: \*Advanced wastewater treatment, \*Denmark, \*Nutrient concentrations, \*Nutrient removal, \*Oxygen depletion, \*Precipitation, \*Scandinavia, \*Wastewater facilities, \*Wastewater treatment, Ammonia, Biological wastewater treatment, Denitrification, Hydrolysis, Nitrates, Nitrogen, Separation techniques.

Oxygen depletion in Danish waters has given rise to demands for removal of nutrients from dis-charged wastewater. In Denmark, research has been conducted on the development of nutrient removal methods for twenty years. Design of new plants is based on the experience gained from existing plants. Removal of nitrogen is by comned from bined nitrification-denitrification by separate sludge systems and combined sludge systems. Separating the aerobic and anoxic tanks facilitates the control of the plant. The Bio-Denitro process is control of the plant. The Bio-Dentito process is being used in approximately 30 plants, with effluent values achieved for ammonia at 1 mg/L or less and for nitrate ranging from 2 to 5 mg/L. An important requirement for obtaining biological phosphorus removal is an efficient denitrification process which prevents nitrate from entering the anaerobic tank with the return sludge. Various anaerobic tank with the return sludge. Various precipitation processes are in use, such as pre-precipitation, simultaneous precipitation, post-pre-cipitation, and contact filtration, and the choice of phosphorus removal process depends on economic and practical considerations. A lack of carbon and energy sources for denitrification can be overcome by extracting suitable organics from sludge by hydrolysis. The Scandinavian HYPRO project uses this process through (1) pre-precipitation for decreasing the load on the biological step by redecreasing the load of the biological step by re-moving organic matter and phosphorus; (2) hy-drolysis of the resultant sludge to produce a sup-plementary carbon source for the biological deni-trification process; (3) biological nitrification-deni-trification using the resultant supernatant. (Brun-per PTF) one-PTT) W91-09375

AEROBIC BIOLOGICAL REGENERATION OF DICHLOROMETHANE-LOADED ACTIVATED

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Gewaesserreinigungstechnik. J. Holst, B. Martens, H. Gulyas, N. Greiser, and I.

Sekoulov.

Journal of Environmental Engineering (ASCE)

JOEEDU, Vol. 117, No. 2, p 194-208, March/
April 1991. 6 fig, 2 tab, 31 ref, append. Bundesministerium fuer Forschung und Technologie Grant

BMFT 02WA8719.

Descriptors: \*Activated carbon, wastewater treatment, \*Carbon regeneration, \*Dichloromethane, \*Wastewater reactors, Wastewater treatment, Adsorption, Biofilm reactors, Biological treatment, Biomass, Oxygenation

Dichloromethane-degrading bacteria, selected from sewage sludge, are employed in a fluidized-bed reactor for the regeneration of dichloromethane-containing activated carbon. Bubble-free oxygenation of the reactor was executed using polydimethylsiloxane tubes. Three run modes of the reactors tor were investigated: (1) aeration of dichloro-

methane-containing activated carbon without bio-mass; (2) treatment of carbon with biomass and mass; (2) treatment of carbon with biomass and oxygenation by low gas flows of pure oxygen; and (3) biodegradation of the adsorbed dichloromethane under conditions of 'dead-end' oxygenation, i.e. oxygenation via closed polydimethylsiloxane tubes with the addition of pressure impulses of pure oxygen when the oxygen concentration in the reactor falls below 2 mg/L). The fluidized bedreactor with dead-end oxygenation was the most advantageous because no exhaust gas was produced and the dichloromethane was degraded totally to HCl and carbon dioxide. The bioregenerated activated carbon exhibited the same adsorption ed activated carbon exhibited the same adsorption capacity as fresh, untreated activated carbon. (Au-thor's abstract) W91-09386

EVALUATION OF BAT FOR VOCS IN DRINK-ING WATER.

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div. R. M. Clark, and J. Q. Adams.

JOURNAI OF Environmental Engineering (ASCE) JOEEDU, Vol. 117, No. 2, p 247-269, March/ April 1991. 9 fig, 6 tab, 19 ref, append.

Descriptors: \*Best available treatment technology, \*Drinking water, \*Granular activated carbon, \*Packed tower aeration, \*Volatile organic compounds, \*Wastewater treatment, \*Water pollution control, \*Water quality control, \*Water treatment, Aeration, Comparison studies, Costs, Dichlorethanes, Economic aspects, Regulations, Vinyl chloride, Water quality monitoring. ride, Water quality monitoring.

Both granular activated carbon (GAC) and packed tower aeration (PTA) are designated as best-available treatment technology (BAT) in the volatile organic chemicals (VOC) regulations. The constant pattern-homogeneous surface diffusion model was used to predict liquid-phase GAC use rates for selected single-solute VOCs. Eight currently regulated VOCs were examined and only p-dichlorobenzene exhibited a bed life greater than two years. Most of the VOCs exhibited bed lives in the range of six to 24 months with empty bed contact times (EBCTs) of 10 and 15 minutes. Three VOCs (1,2-dichloroethane; 1,1,1-trichloroethylene; and vinyl chloride) had predicted bed lives of less than three months. Preliminary cost estimates for liquid-phase GAC treatment systems can be developed for a Both granular activated carbon (GAC) and packed GAC treatment systems can be developed for a range of plant sizes, EBCTs and carbon bed lives. Cost estimates for the liquid-phase GAC treatment systems ranged from about 34 to 45 cents/1000 gallons (9 to 12 cents/cu m) for a 1 mgd (3785 cu m/day) system, to about 20 to 30 cents/1000 galm/day) system, to about 20 to 30 cents/1000 gallons (5 to 8 cents/cu m) for a 10 mgd (37,850 cu m/day) system, to about 11 to 15 cents/1000 gallons (3 to 4 cents/cu m) for a 100 mgd (37,850 cu m/day) system. Costs for PTA systems excluding off-gas control varied from about 49 cents/1000 gallons (13 cents/cu m) (treating 1,2-dichloroeth-ane) to 35 cents/1000 gallons (9 cents/cu m) (treating vinyl chloride) for a 0.1 mgd (378 cu m/day) system, 21 cents/1000 gallons (10 cents/cu m) for a 1 mgd (3875 cu m/day) system, and 14 cents/1000 gallons to 6 cents/1000 gallons (4 cents/cu m) for a 10 mgd (37,850 cu m/day) system. For all vOCs in a comparison between GAC and PTA, PTA treatment was more cost-effective than PTA treatment was more cost-effective than liquid-phase GAC at all system sizes if no PTA off-gas control is needed. When PTA off-gas control gas control is needed. When PTA off-gas control was included, cost trade-offs between PTA and GAC were seen at various systems sizes. This analysis exposes the sensitivity of GAC and PTA costs to variations in design and operating parameters, but the evaluation of alternative treatment technologies must be made on a case-by-case basis, taking site-specific conditions. (Brunone-PTT) W91-09389

CADMIUM AND ZINC BIOSORPTION BY CHLORELLA HOMOSPHAERA.

Centro de Tecnologia Mineral, Rio de Janeiro (Brazil)

A. C. A. Costa, and S. G. F. Leite. Biotechnology Letters BILED3, Vol. 12, No. 12, p 941-944, December 1990. 2 fig, 14 ref.

### **Group 5D—Waste Treatment Processes**

Descriptors: \*Absorption, \*Cadmium, \*Chlorella, \*Heavy metals, \*Wastewater treatment, \*Water pollution treatment, \*Zinc, Bioaccumulation, Brazil, Chlorophyta, Ecological effects, Fate of

The current industrial practice of discharging un-desirable toxic metallic ions, such as lead, zinc, and cadmium, into the environment has stimulated a growing interest in methodologies to remove these metals by microbial action. The prevalence of high concentrations in several regions of Rio de Janeiro has prompted this study on the potential employ-ment of the green microalga Chlorella homosphaera in aqueous systems to minimize the pollu-tion and ecological disruption caused by metallic ions. Cadmium and zinc biosorption by Chlorella cells were tested in a range of concentrations from 0.5 to 14.0 mg/L. Two distinct phases were observed for cadmium biosorption: a rapid phase probably associated with metal adsorption around the cell wall and a slower phase associated with transport into the cell interior. For zinc biosorption the phases were not distinct probably due to the metabolic use of zinc by the algal cells. For the metabolic use of zinc by the algal cells. For both metals, the higher the metal concentration the less effective was the percent ion removal, resulting from toxicity on the cells and saturation of biological reaction sites. At equal concentrations, zinc was removed to a higher degree than cadmium. (D'Agostino-PTT)
W91-09421

PARTITIONING OF POLYCARBOXYLIC ACIDS IN ACTIVATED SLUDGE.

ACIDS IN ACTIVATED SLUDGE.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
S. Yeoman, J. N. Lester, and R. Perry.
Chemosphere CMSHAF, Vol. 21, No. 4/5, p 443-450, 1990. 6 fig, 1 tab, 25 ref. Supported by the Centre Europeen d'Etudes des Polyphosphates

Descriptors: \*Activated sludge, \*Detergents, \*Polycarboxilic acids, \*Radioactivity techniques, \*Sludge solids, \*Wastewater treatment, Activated sludge process, Activated sludge treatment, Hy-drocarbons, Inorganic compounds, Laundry detergent, Separation techniques

The proposed use of polycarboxylic acids (PCAs) in laundry detergent formulations as co-builders necessitates study of their eventual environmental fate and public health implications. Since wastewater treatment is the major process governing their removal, impact assessment of the substitution of inorganic substances even partially by PCAs requires defined analytical procedures for detection and quantification of specific polymers. Such environmental characterization is difficult, however, since these methods are almost impossinowever, since these methods are almost impossi-ble to develop for complex matrices such as acti-vated sludge. In the present study, the partitioning of a radiolabeled 14PCA in activated sludge was investigated. Most of the radioactivity and hence PCA polymer was found associated with the settle-able solids, very little remained in the supernatant, with even less released as 14carbon dioxide. This, along with the fact that 14PCA was elutable from the sludge solids, indicates that adsorption and precipitation after dilution is probably the most significant removal mechanism of polymeric detergent builders. (D'Agostino-PTT) W91-09426

FORMATION OF NON-VOLATILE POTENT MUTAGENS IN DOMESTIC SEWAGE BY CHLORINATION.

Kyoto Pharmaceutical University, Yamashina-ku,

Kyoto, Japan, 607. S. Fukui, Y. Yoshimura, S. Ogawa, and Y.

Hanazaki.

Chemosphere CMSHAF, Vol. 21, No. 6, p 705-716, 1990. 2 fig, 6 tab, 18 ref. Supported by the Science Promoting Fund of Kyoto Pharmaceutical University.

Descriptors: \*Activated sludge process, \*Activated sludge treatment, \*Chlorination, \*Drinking compounds, \*Mutagens, \*Wastewater treatment,

\*Water treatment, Ames test, Chemical mutagens, High performance liquid chromatography, Humic inces, Japan, Mutagenicity, Separation tech-

Non-volatile mutagens, formed by the chlorination Non-volatile mutagens, formed by the crinorianon of humic substances, are often found in tap water disinfected with chlorine. Current concern that these mutagens may also be derived from domestic sewage treated by activated sludge systems prompted the present study of sludge waste water effluents from a Japanese municipal plant. Chloring the domestic services carpales were attracted with ated domestic sewage samples were extracted with Amberlite XAD resins and evaluated for mutage-Amberlite XAD resins and evaluated for mutage-nicity by the Ames test and taped plate assay. Sewage before chlorination did not demonstrate mutagenicity in S. typhymurium TA 100, howev-er, following chlorination the sewage exhibited dose-related mutagenic activity (5000-3000 rever-nants/L) that was enhanced 5 to 50-fold over that in non-chlorinated sewage. Both volatile and non-volatile mutagens were detected. Fractionation of volatile mutagens were detected. Fractionation of XAD extracts by high-performance liquid chromatography indicated that mutagenicity was due to the presence of several substances rather than to a single distinguishing constituent. (D'Agostino-PTT) W91-09435

AVAILABILITY AND SUITABILITY OF MU-NICIPAL WASTEWATER INFORMATION FOR USE IN A NATIONAL WATER-QUALITY ASSESSMENT: A CASE STUDY OF THE UPPER ILLINOIS RIVER BASIN IN ILLINOIS, INDIANA, AND WISCONSIN.
Geological Survey, Urbana, IL. Water Resources

For primary bibliographic entry see Field 5A. W91-09485

EFFECTS OF AROMATIC CONCENTRATION ON METHANE FERMENTATION. Kentucky Water Resources Research Inst., Lex-

ington.
Y. T. Wang, P. C. Pai, and H. D. Gabbard.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-107318/ AS. Price codes: A08 in paper copy, A08 in micro-fiche. Research Report No. 174. August 1990. 156p, 16 tab, 112 fig, 74 ref. USGS Contract No. 14-08-0001-G1564.

Descriptors: \*Anaerobic digestion, \*Aromatic compounds, \*Biodegradation, \*Fermentation, \*Methane, \*Wastewater treatment, Acetates, Analytical techniques, Bioassay, Inhibition, Kinetics, Model studies, Phenols.

The anaerobic biodegradability and toxicity of The anaerobic biodegradability and toxicity of fourteen aromatic compounds were evaluated over a wide range of concentrations using a serum bottle technique. Benzene, toluene, and all three isomers of xylene were not significantly degraded to methane in a phenol-enriched culture. Complete degradation of 1000 mg/L phenol 800 mg/L catechol, 100 mg/L 2-NP, 100 mg/L 3-NP, and 100 mg/L 4-NP was observed within two months while depletion of 100 mg/L resorcinol and 1000 mg/L hydroguinone required more than six and mg/L hydroquinone required more than six and eight months incubation, respectively. None of the three isomers of chlorophenol were degraded in the phenol-enriched culture. Batch toxicity assay revealed that the phenol-enriched culture was more susceptible to inhibition caused by substituted phenols than the acetate-enriched culture. In gen-eral, the inhibitory effects on both phenol degrada-tion and acetate utilization did not vary significantly with the isomer but rather with the substituted group. The degree of inhibition was in the order of group. The degree of infinition was in the order or introphenols chlorophenols hydroxphenols. The Haldane inhibition model was used to fit experimental data from phenol and catechol. The inhibition of phenol degradation by chlorophenols, resorcinol, and hydroquineone was described rather well by a Monod-type noncompetitive model. (USGS) W91-09503

NATURAL PROCESSES FOR TERTIARY TREATMENT OF MUNICIPAL WASTEWATER

COUPLED WITH SHALLOW GROUND-WATER DISCHARGE IN A SALTWATER MARSH ENVIRONMENT - A CASE STUDY,

MARSH ENVIRONMENT - A CASE STUDY. Hydro Systems, Inc., Berlin, MD.
T. E. Dwyer, and K. A. Sylvester.
IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 237-260. 6 fig, 4 tab, 4 ref.

Descriptors: \*Injection wells, \*Municipal wastewater, \*Salt marshes, \*Wastewater disposal, \*Wastewater treatment, \*Wetlands treatment, Denitrification, Land disposal, Nutrient removal, Sanitary engineering, Shallow groundwater, Tertiary wastewater treatment, Underground waste disposal

A natural treatment system coupled with ground-water recharge wells has proven to be an environ-mentally safe and cost-effective means of treating and disposing of municipal wastewater in a salt water marsh environment on Maryland's Eastern Note: In this system, conventional secondary biological treatment is followed by three intermediate treatment steps involving different land-application techniques. The principal functions of the three treatment steps are: ammonium ion removal; deni-trification/filtration; and purification/adsorption. Additional benefits of the treatment steps include oxidation of soluble organic material and removal of suspended solids, phosphorus, trace elements, and trace organics. Each step, in addition to performing its own specific treatment function, backsup the previous steps and prepares the water for the following step. The final polished effluent meets current drinking water and nutrient-removal standards and is suitable for discharge into the shallow groundwater flow system through injection wells. The injection wells are located in a tion wells. The injection wells are located in a unique hydrogeologic setting that protects the fragile saltwater marsh from a sudden influx of highly-polished wastewater. A shallow, confined saltwater aquifer underlying a man-made upland hummock serves as the disposal zone. The upper confining unit is composed of compressed marsh sediments, while the layer confining layer is comparable to the confined service of the confined service of the confined layer confining layer is comparable to the confined service of the confined serv sediments, while the lower confining layer is com-posed of silty/clayey marine sediments. The inject-ed water, after considerable travel time, eventually discharges into the adjacent bay as diffuse ground-water flow. (See also W91-09628) (Author's abstract) W91-09641

ESTIMATING OXYGEN REQUIREMENTS AND WASTE SLUDGE FROM ACTIVATED SLUDGE WITH AND WITHOUT PRIMARY CLARIFIERS TREATING MUNICIPAL WASTEWATER.

Eckenfelder, Inc., Nashville, TN. W. W. Eckenfelder.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 793-798, 1990. 2 fig, 3 ref.

Descriptors: \*Activated sludge, \*Activated sludge process, \*Wastewater treatment, Clarifiers, Oxygen requirements, Sludge.

In many activated sludge plants which treat municipal wastewaters, primary solids undergo a two-stage process, degradation and endogenous oxida-tion. Depending on the sludge retention time (SRT) of the system, both oxygen requirements and sludge production differ in the absence of primary clarifiers and elimination of the primary settling tank impacts significantly on plant design and performance. In a 10 day SRT, the hydraulic and performance. In a 10 day SR1, in Inglitatine residence time sharply increased from 0.45 to 0.7 days without a primary clarifier. Also, the biological composition of the wasted sludge increased from 39 to 66%, adversely affecting both sludge digestion and dewatering. (D'Agostino-PTT) W91-09657

FATTY ACIDS REMOVAL FROM EFFLUENT

ON MINERAL FINES.
Thessaloniki Univ., Salonika (Greece). Lab. of General and Inorganic Chemical Technology.
G. P. Gallios, and K. A. Matis.

### Waste Treatment Processes—Group 5D

Vol. 11, No. 9, p 811-820, 1990. 10 fig, 15 ref.

Descriptors: \*Adsorption, \*Fatty acids, \*Flotation, \*Mineral fines, \*Sorption, \*Wastewater treatment, Effluents, Minerals.

Although most of the reagents introduced into a mineral beneficiation circuit are removed during processing, significant amounts of fatty acids (the usual anionic collectors) still remain in the final effluent. This study demonstrates that adsorption onto mineral fines in the presence of modifiers is an onto mineral lines in the presence of modifiers is an effective method for their removal. The fatty acids can then be successfully floated by conventional froth as well as dissolved-air and electrolytic flotation. This procedure is potentialy usable both as a purification process for industrial wastewaters and also a utilization method for fines, which are otherwise discarded, in the mine area. (D'Agostino-PTT) W91-09658

# ANAEROBIC BIODEGRADABILITY OF PAPER MILL WASTEWATER CONSTITU-

ENIS, Agricultural Univ., Wageningen (Netherlands). Dept. of Environmental Technology. R. Sierra-Alvarez, M. Kato, and G. Lettinga. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 891-898, 1990. 6 fig, 1 tab, 39 ref.

Descriptors: \*Anaerobic digestion, \*Biodegradation, \*Pulp and paper industry, \*Wastewater treat-ment, Effluents, Fatty acids, Lignin, Resins, Sludge digestion, Sludge treatment, Toxicity, Sludge digestion, Sl Toxins, Wood wastes.

Although anaerobic wastewater treatment methods Although anaerobic wastewater treatment methods are gaining in importance, their application in paper and pulp manufacturing is largely limited to non-inhibitory paper mill effluents. The anaerobic biodegradability of wood resin constituents and low molecular weight lignin derivatives was evaluated under methanogenic conditions. Degradation was evaluated in batch bioassays inoculated with anaerobic granular sludge at 30 + 0 -2C using low concentrations of the test chemicals (35-200 mg/L-1) to prevent methanogenic inhibition. Long-chain 1) to prevent methanogenic inhibition. Long chain fatty acids (oleic and linoleic) were readily biodegradable. Guaiacol was mineralized after a 40 day lag period. No degradation was detected for eugenol, benzene, the resin acids (abietic and dehyroabietic), the volatile terpines (pinene and limonene), or the unsaturated hyrocarbon squalene. Anaerobic treatments have a limited capacity to mineralize wood toxins and should be combined with other processes to eliminate residual toxicity in paper mill effluents. (D'Agostino-PTT)

### EFFECTS OF TEMPERATURE ON ANAERO-BIC FILTER TREATMENT FOR STRENGTH ORGANIC WASTEWATER.

National Inst. for Environmental Studies, Ibaraki (Japan).

(Sapan). K. Matsushige, Y. Inamori, M. Mizuochi, M. Hosomi, and R. Sudo. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 899-910, 1990. 10 fig, 5 tab, 18

Descriptors: \*Anaerobic filters, \*Anaerobic treatment, \*Organic wastes, \*Temperature effects, \*Wastewater treatment, Electric power demand, Filters, Mathematical studies, Retention time.

Since almost 40% of the total electical energy in Since almost 40% of the fortal electrical energy in ordinary biological wastewater treatment plants is used for aeration, the use of the anaerobic filter process is gaining popularity, particularly in small-flow treatment plants. The effects of water temperature and HRT on treatment efficiency in the anaerobic filter process were examined based on laboratory-scale experiments. The treatment effinatoratory scare experiments. The treatment en-ciency of the anaerobic filter process was affected by water temperature and HRT. Treatment effi-ciency was enhanced if water temperature was increased with the HRT kept constant, or if the HRT was extended with the water temperature kept constant. The yield coefficient of anaerobic microorganisms in a tank became small if the water

temperature was increased. The endogenous decay coefficient was very small compared with the values for the activated sludge process. In the anaerobic filter process for low-strength wastewater, a mathematical model for estimating the treatment efficiency was developed based on the experimental results, assuming that the specific substrate removal rate obeys a first-order reaction. The calculated concentrations in the effluent were in fair agreement with the observed concentrations. The dependency of the specific substrate removal process on water temperature was evaluated using Arrhenius plotting extrapolations and an empirical temerature-dependent equation. The activation energies and temperature coefficients were 23,500 cal/mole and 1.515 with BOD and 16,600 and 1.105 with TOC, respectively. (D'Agostino-PTT) W91-09666

## APPLICATIONS OF BIOPOLYMERS TO PROCESSES OF ENVIRONMENTAL CON-

Universita degli Studi 'La Sapienza', Rome (Italy). Dipt. di Chemica. M. Achilli, L. Campanella, V. Crescenzi, M.

nr. Acmin, L. Campanella, V. Crescenzi, M. Dentini, and A. I. N. Scheffino. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 911-918, 1990. 8 fig. 1 tab, 11 ref. Supported by the National Research Council of Italy.

Descriptors: \*Cellulose acetate membranes, \*Heavy metals, \*Polyelectrolytes, \*Polymers, \*Trace metals, \*Wastewater treatment, Adsorption, Biopolymers, Copper, Diffusion, Electrolytes,

Traditional methods for the removal of heavy metals from aqueous solutions are often plagued by high costs and secondary pollution problems. A polyelectrolyte entrapment procedure using new polyelectrolyte entrapent procedure using cellulose triacetate (TAC) membranes was devel-oped. Adsorption efficiency was tested by moni-toring cupric ion immobilization with a copper ion selective electrode. With the synthetic polyelectro-lyte MAEVE, a higher adsorption efficiency was observed when the ions were added to the TAC suspension before polymerization as compared to diffusion into preformed membranes. For the natural TA-1 polymer the diffusion method was required due to insolubility of the polymer in the TAC suspension. Increasing membrane thickness resulted in increased adsorption, however, ion re-moval by EDTA was less efficient from thicker membranes. Column adsorption and elution procedures displayed shorter operating times than the batch stirring method. (D'Agostino-PTT)

# EFFECT OF CHLORINE ON PHOTOCATALY-TIC DEGRADATION OF ORGANIC CON-TAMINANTS.

TAMINANIS.
Turin Univ. (Italy). Dipt. di Chimica Analitica.
V. Carlin, C. Minero, and E. Pelizzetti.
Environmental Technology (Letters) ETLEDB,
Vol. 11, No. 10, p 910-926, 1990. 4 fig, 21 ref. CEE
contract EV4V-0068-C (CD).

Descriptors: \*Chlorination, \*Chlorine, \*Disinfection, \*Organic pollutants, \*Photolysis, \*Wastewater treatment, Atrazine, Chlorinated aromatic compounds, Chlorinated hydrocarbons, Her-

Chlorination is a widely used wastewater disinfectant process which has been found to alter the efficiency of subsequent treatment protocols. The effect of chlorine on the photocatalytic degrada-tion of 2-chlorophenol and the herbicide, atrazine, in water was examined. Small quantities of Cl2 as usually adopted in chlorination processes (20-70 usually adopted in chlorination processes (20-70 ppm) do not markedly affect (or exhibit a slight inhibition effect on) clorophenol and atrazine photocatalytic degradation. When free chlorine reacts with phenols adsorbed on granular activated carbon, many additional products are formed. The formation of chlorohydroxybiphenyls is of particular activated the context of the carbon that the context of the carbon that the context to the carbon that the context of the carbon that lar concern because of their potential toxicity. The rate of degradation of these organic pollutants was faster at higher chlorine concentrations, particular-

ly for 2-chlorophenol, and unaffected or slightly inhibited at lower concentrations. No difference in the formation of final products (CO2 for 2-chlorophenol and cyanuric acid for atrazine) was observed. (D'Agostino-PTT) W91-09668

# CHANGES AND VARIABILITY IN CONCENTRATION OF HEAVY METALS IN SEWAGE SLUDGE DURING COMPOSTING.

Massachusetts Univ., Amherst. Dept. of Civil Engineering.

D. J. Wagner, G. D. Bacon, W. R. Knocke, and

D. J. wagner, U. D. Bacon, W. R. Khocke, and M. S. Switzenbaum. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p. 949-960, 1990. 1 fig. 3 tab, 19 ref. Massachusetts Division of Water Pollution Control Research and Demonstration Project Contract no. 87-01-2

Descriptors: \*Composting, \*Heavy metals, \*Sewage sludge, \*Sludge, \*Sludge treatment, \*Wastewater treatment, Cadmium, Chromium, Lead, Sludge disposal, Variability, Zinc.

Sludge composting is among the most promising new methods for sewage sludge treatment and resource recovery. Composted sludge is aesthetically acceptable, essentially pathogen free, easy to handle, and valuable to the soil. A significant obstacle, however, is contamination with heavy metals since the type of land for sludge disposal becomes more restrictive as the metal concentration increases. Variation in heavy metal concentra-tion was monitored in sewer sludge and compost within a given batch-pocessed pile and from batch to batch over several months. The concentrations of cadmium, chromium, lead, and zinc increased during composting; whereas, copper and nickel concentrations decreased. Cadmium and lead varied the most, copper and zinc the least. Al-though intrabatch variability was small (4-12%), batch to batch differences were significantly larger (4-37%). The variability of sludge entering and of compost exiting the process were similar for each metal. (D'Agostino-PTT) W91-09671

### COMPARATIVE STUDY FOR BIOSORPTION CHARACTERISTICS OF HEAVY METAL IONS WITH C. VULGARIS.

Hacettepe Univ., Ankara (Turkey). Dept. of Chemical Engineering.

Z. Aksu, and T. Kutsal. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 979-987, 1990. 7 fig, 3 tab, 9 ref.

Descriptors: \*Algae, \*Biosorption, \*Chlorella, \*Chlorophyta, \*Heavy metals, \*Wastewater treatment, Adsorption, Chromium, Contamination, Copper, Hydrogen ion concentration, Industrial tes. Iron. Lead. Temperature. Zinc.

Industrial wastewaters from a wide variety of sources are usually contaminated with at least one or two heavy metal ions. Chemical-based methods for removal of these pollutants may be ineffective or prohibitively expensive when the initial ion concentrations are in the range of 10-100 g/cum. Biosorption by microbial cells is a potential alter-Biosorption by microbial cells is a potential alternative for metal recovery from industrial waste streams and natural waters. The kinetics of biosorption in waste water of Cu(II), Zn(II), Fe(II), Cr(VI), and Pb(II) ions to the green alga, Chlorella vulgaris, were investigated in a stirred batch reactor. The optimum adsorption temperatures and initial pH values for each ion were 25C, 35C, 25-35C, 35-50C, 35C, and pH 4.0-4.5, 1.0-2.0, 1.5-2.0, 5.0, respectively. Initial concentrations of 200 ppm gave the highest adsorption rates for most of the ions. Corresponding Freundlich adsorption constants and degree of the constants and degree of the second constants and degree of the second constants and degree of the constants are constants and degree of the constants and constants are constants. constants and degrees were also determined from isotherms constituted at 25C. The results showed that dried green algae were good adsorbing media for metals and could be suitable for large-scale wastewater purification. (D'Agostino-PTT)

### **Group 5D—Waste Treatment Processes**

EFFECTS OF THE CIRCULATION RATIO ON THE TREATMENT OF ARTIFICIAL DOMES-TIC WASTEWATER USING THE ANAEROBIC-AEROBIC CIRCULATION FILTER PROCESS National Inst. for Environmental Studies, Ibaraki

National History (Japan).

K. Matsushige, Y. Inamori, M. Mizuochi, M. Hosomi, and R. Sudo.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 11, p 989-998, 1990. 4 fig. 8 tab, 13 ref.

Descriptors: \*Anaerobic-aerobic filters, \*Domestic wastewater, \*Filters, \*Nitrogen compounds, \*Nitrogen removal, \*Organic pollutants, \*Wastewater treatment, Circulation ratio, Denitrification, Organic compounds. Sludge treatment.

The anaerobic-aerobic circulation filter (AACF) process was developed in order to remove both organic matter and nitrogen from low-strength domestic wastewater with reduced energy requirements and easy plant maintenance. The effects of the circulation ratio on the efficiency of nitrogen removal by the AACF method were evaulated. The reaction in the aerobic filter was efficient at all circulation ratios tested: 1,2 and 4, with a denitrifi-cation rate of more than 90%. The amount of daily nitrogen removal in the anaerobic filter tank was highest at a circulation ratio of 4, with a removal rate of 75%. In both filters, the consolidation of nigness at a circulation ratio of 4, with a removal rate of 75%. In both filters, the consolidation of sloughed biofilm was good at all ratios. The sludge conversion rate was less than 6% in all cases. There was no significant difference in the removal efficiency of organic matter in either the anaerobic filter or the aerobic filter at all circulation ratios, and the gas composition generated in the anaerobic filter showed that denitrification could be more effectively achieved at a higher circulation ratio. Dominant microorganisms appearing in the anaer-obic filter were Trymyema sp. and Paramecium sp. of ciliata and Beggiatoa sp. of filamentous sulfur bacteria. Euglypha sp and Centropyxis sp. of Arcellinida, which are microorganisms indicating sufficient progression of the nitrification reaction, appeared dominantly in the aerobic filter. (D'Agostino-PTT) effectively achieved at a higher circulation ratio. W91\_09673

CARBON-FELT FLOW-THROUGH ELEC-TRODE IN WASTE WATER TREATMENT: THE CASE OF MERCURY (II) ELECTRODE-POSITION.

Universite de Pau et des Pays de l'Adour (France).

Lab. de Chimie Analytique.

B. Delanghe, S. Tellier, and M. Astruc.
Environmental Technology (Letters) ETLEDB,
Vol. 11, No. 11, p 999-1006, 1990. 5 fig, 2 tab, 25

Descriptors: \*Brines, \*Carbon/felt electrodes, \*Electrochemistry, \*Electrodes, \*Heavy metals, \*Mercury, \*Wastewater treatment, Electrodeposition, Flow rates, Sludge volume.

The utilization of carbon felt flow-through electrodes was evaluated as an alternative method for the removal of mercury (II) from contaminated brines. Correlations between the product of the specific surface area and the mass transfer coefficient and the flow rate were established for various thicknesses of carbon felt and used to calculate the electrochemical reactor size under given chemical and hyrodynamic conditions. The carbon felt electrode was shown to be the most efficient three-dimensional electrode tested, up to 97% at a flow dimensional electrode tested, up to 91% at a flow rate of 36 m/h and only slightly lower, 90%, in very dilute solutions of 100 microg/L. Advantages also include continuous operation, small toxic sludge volume, no overload of pollutants, no addi-tional facilities requirement, and easy recovery of electrodeposited mercury. (D'Agostino-PTT) W91-09674

SEPARATION OF RADIONUCLIDES FROM LIQUID WASTE USING A MINERAL MIX-TURE

Pakistan Inst. of Nuclear Science and Technology. Islamabad. Nuclear Chemistry Div. S. Ahmad, and I. H. Qureshi.

Separation Science and Technology SSTEDS, Vol. 24, No. 7/8, p 569-579, June/July 1989. 6 fig.

2 tab. 25 ref.

Descriptors: \*Decontamination, \*Liquid wastes, \*Mineral oxides, \*Radioactive wastes, \*Radioisotopes, \*Separation techniques, \*Waste treatment, \*Wastewater treatment, Adsorption, Cesium radioisotopes, Effluents, Nuclear powerplants, Sorption. Strontium radioisotopes.

Natural sorption materials are potentially useful in radioactive waste management due to their high radiochemical and thermal resistance, low cost, and abundant availability. In addition, mixed hydrous oxides are better ion exchangers than individual ones. The use of a naturally available mineral mixture (MM) for the decontamination of lowal mixture (MM) for the decontamination of low-level radioactive liquid waste was investigated. The results show that loading capacity can be achieved up to 35 g/kg for Cs and 25 g/kg for Sr. Cesium has more loading capacity as compared to Sr because of its greater affinity for iron-containing minerals. These results indicate that 137Cs and mineras. These results indicate that 17Cs and 90Sr fixation can be achieved in less than 2 min, for a wide range of pH values. In addition, efficient adsorption of 137Cs, 134Cs, and 90Sr (constituting 80% of fission products) was observed when optimum conditions of equilibration time and reactant concentrations were used. Removal of Cs and Sr by MM suggests its use for on-line radionuclide isolation from nuclear facility effluents followed by long term storage in the resultant reduced solid form. (D'Agostino-PTT)

COMPUTER PREDICTION OF MULTICOM-PONENT SORPTION WITH VARIABLE INI-TIAL CONCENTRATIONS USING A COM-PLEX MODEL.

Jordan Univ. of Science and Technology, Irbid.

Dept. of Chemical Engineering.
A. R. Mansour, A. Nusayr, D. U. Von Rosenberg,

and N. D. Sylvester.

Separation Science and Technology SSTEDS,
Vol. 24, No. 11, p 697-708, September 1989. 5 fig, 1

Descriptors: \*Activated carbon, \*Mathematical models, \*Model studies, \*Sorption, \*Wastewater treatment, Adsorption, Design criteria, Feedwater treatment, Multisolute sorption, Variable concentrations, Wastewater facilities.

It is rare that the inlet concentrations of pollutants to be removed during wastewater treatments will remain constant throughout the process. The imchanges for multisolute adsorption processes were examined. A generalized computer-assisted mathe-matical model is described for adsorption on acti-vated carbon in fixed beds for a ternary system. As shown by both the sharpness and broadness of the generated breakthrough curves, the feed composigenerated orleations (actives, the feet composi-tion (and concentrations) is one of the most impor-tant factors affecting the design of multisolute ad-sorbers. (D'Agostino-PTT) W91-09682

STIMULATION OF MULTICOMPONENT SORPTION PROCESSES WITH AXIAL DIFFU-

Jordan Univ. of Science and Technology, Irbid. Dept. of Chemical Engineering.

Separation Science and Technology SSTEDS, Vol. 24, No. 12/13, p 1047-1058, October 1989. 4 fig, 2 tab, 36 ref.

Descriptors: \*Activated carbon, \*Mathematical models, \*Separation techniques, \*Sorption, \*Wastewater treatment, \*Water treatment, Adsorption kinetics, Computer programs, Design criteria, Diffusion, Dispersion, Hydrodynamics. Isotherms

Multicomponent adsorption onto activated carbon is finding increasing application in the purification of domestic and industrial water and wastewater. Mathematical prediction of liquid-phase tions is of fundamental importance for the engineering design of efficient adsorption systems and axial dispersion may play an important role in the separation process. A complex model was developed to numerically simulate the multicomponent adsorption kinetics of binary and ternary systems. The model considers fluid resistance, internal and external diffusion resistances with axial diffusion, and a highly nonlinear equilibrium isotherm. Excellent agreement with experimental data was obtained. The adjunctly developed computer program can be accurately used for any number of components in any complex multicomponent system. Dispersion data showed that axial diffusion exerted only minimal effects on either the shape or system. Dispersion data smowed that axial diffusion exerted only minimal effects on either the shape or sharpness of the breakthrough curves. Axial dispersion can be neglected as a factor in the simulation and design of multicomponent fixed-bed adsorbers. (D'Agostino-PTT)

SLUDGE MANAGEMENT: CAPITAL IMPROVEMENTS.

Professional Services Group, Inc., Houston, TX. For primary bibliographic entry see Field 5E. W91-09775

EFFECT OF SPRAY IRRIGATION OF TREAT-ED WASTEWATER ON WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM, REEDY CREEK IMPROVEMENT DISTRICT, CEN-TRAL FLORIDA.

Geological Survey, Orlando, FL. Water Resources

For primary bibliographic entry see Field 5E. W91-09844

PHYSICOCHEMICAL AND HYDRODYNAMIC EFFECTS ON COLLOIDAL FOULING REDUCTION IN REVERSE OSMOSIS.

Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering. For primary bibliographic entry see Field 3A. W91-09860

RURAL RESIDENTIAL DEVELOPMENT: EVOLUTION OF A SEPTIC SYSTEM REGULA-TORY PROGRAM.

New Mexico Health and Environment Dept., Santa Fe. Environmental Improvement Div. For primary bibliographic entry see Field 5G. W91-09893

TWO-PRONGED APPROACH TO SLUDGE COMPOSTING.

For primary bibliographic entry see Field 5E. W91-10218

SEPTAGE DEWATERING, TREATMENT AND COMPOSTING

E and A Environmental Consultants, Inc., Cary, For primary bibliographic entry see Field 5E. W91-10219

INCINERATION OF CREOSOTE AND PEN-TACHLOROPHENOL WOOD-PRESERVING WASTEWATER TREATMENT SLUDGES,

PEI Associates, Inc., Cincinnati, OH.
For primary bibliographic entry see Field 5E. W91-10234

IN-SITU STABILIZATION/SOLIDIFICATION OF PCB-CONTAMINATED SOIL.

Environmental Protection Agency, OH. Risk Reduction Engineering Lab. Cincinnati. For primary bibliographic entry see Field 5G. W91-10239

PRELIMINARY DATA SUMMARY DRUM RECONDITIONING INDUSTRY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5E. W91-10241

### Waste Treatment Processes—Group 5D

PRELIMINARY DATA SUMMARY FOR THE HAZARDOUS WASTE TREATMENT INDUS-

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126517. Service, Springletti, VA. 22101, as 1790-122017. Price codes: A09 in paper copy, A01 in microfiche. Report No. EPA/440/1-89/100, September 1989. 174p, 4 fig. 54 tab, 32 ref. EPA Contract Nos. 68-03-3509, 68-03-3366, and 68-03-3339.

Descriptors: \*Hazardous wastes, \*Waste disposal, \*Wastewater treatment, Aquatic life, Biochemical oxygen demand, Flow rates, Heavy metals, Incineration, Landfills, Leachates, Organic carbon, Public health, Toxicity.

The hazardous waste treatment (HWT) industry has three subcategories: landfills with leachate collection and treatment facilities; incinerators with section and treatment racitities; incinerators with met scrubbers, and aqueous hazardous waste treaters. EPA Regions V and VI had the largest number of hazardous waste landfills and incinerators. The largest number of aqueous waste treatment facilities were in EPA Region V. Observations made concerning raw landfill leachates intions made concerning raw landfill leachates include: very high concentrations (> 100,000 microgm/L) or toxic organic compounds, high concentrations of BOD, COD, and TOC; volatile organics (VOCs) frequently were found in leachates, while non-volatile compounds may be present but were not readily detected; flow rates varied widely due in part to climatic and geological conditions, but were not related to the size of the landfill; and, high concentrations of Al, Fe, Mn, and B, while the concentrations of toxic metals varied from below detection to > 100 mg/L. Raw wastewaters from the incinerator wet scrulber subcategory below detection to > 100 mg/L. Raw wastewaters from the incinerator wet scrubber subcategory were characterized by: low pH, high TDS, and high chlorides; high concentrations of metals, with AI, Fe, Pb, Zn, Hg, and Cu at the highest concen-trations; and, flow rates averaging 93,000 gpd but ranging as high as 350,000 gpd. Observations re-garding the pollutants in raw aqueous hazardous wastes were: high concentrations of BOD, COD, and TOC, the organics found most frequently at garding the pollutants in raw aqueous hazardous wastes were: high concentrations of BOD, COD, and TOC; the organics found most frequently at the highest concentrations were industrial solvents; metals found at the highest concentrations were Cr, Cu, Ni, Zn, Fe, Al, B, and Mn; flow rates at these facilities averaged 45,000 gpd and ranged from 13,600 to 117,000 gpd. A wide range of treatment technologies was employed for leachate treatment; including treatment and discharge and including treatment. treatment, including treatment and discharge, re-circulation, solidification and reburial, deep well circulation, solidification and reburial, deep well injection, and contract hauling. In addition to treatment and disposal systems, other methods of scrubber wastewater disposal included landfill, evaporation, and contract hauling. Indirect discharges of untreated wastewater may cause POTWs to exceed human health criteria for 12 pollutants, acute aquatic life criteria/toxicity levels for 7 pollutants, chronic aquatic life criteria/toxicity levels for 10 pollutants, and drinking water criteria for 4 pollutants in their receiving streams. In addition, six pollutants may have detrimental impacts on POTWs (6 causing POTW treatment inhibition, 6 causing sludge contamination problems). (Lantz-PTT)

PERFORMANCE OF FULL SCALE HYDRAU-LIC TESTS FOR A FIXED BIOMASS WASTE WATER TREATMENT PROCESS (DURCH-FUHRUNG VON GROSSTECHNISCHEN HY-DRAULISCHEN VERSUCHEN FUER EIN TRA-GERGEBUNDENES BIOLOGISCHES ABWAS-SERREINIGUNGSVERFAHREN).

Linde Aktiengesellschaft, Werksgruppe TVT, 8023 Hollriegelskreuth, Germany.

H. Feldkirchner, U. Fuchs, H. Reimann, and A. Wildmoser. Available from the National Technical Information Service, Springfield, VA. 22161, as TIBA 8882163. Price codes: A06 in paper copy, A01 in microfiche. Report No. BMFT FB, October 1985. 80p, 39 fig. 10 tab. English summary.

Descriptors: \*Biological wastewater treatment, \*Biomass, \*Hydraulic properties, \*Wastewater treatment, Aeration, Biological treatment.

A process has been developed for biological wastewater treatment using open cell foam parti-cles, which move freely in an aeration basin, as a cies, which move reery in an aeration basin, as a carrier of biomass. Application to full-scale longi-tudinal fine bubble aeration basins demanded that solutions be found to the following problems: the hydraulic response of the carrier material had to be cleared; the recycle of material to the inflow end cleared; the recycle of material to the inflow end of the basin had to be tested; and, the retention of the material inside the basin had to be assured under practical operational conditions. These tests have been carried out in two basins, one 1400 cu m in volume and another 570 cu m in volume. The problems were solved by investigating using a stepwise technical refinement, with results indicating that the system can work with four basins of 570 cu m volume each. (Author's abstract)

BIOLOGICAL DEGRADATION OF CYANIDE BY NITROGEN-FIXING CYANOBACTERIA. Minnesota Univ., Minneapolis. Dept. of Civil and

Mineral Engineering.
C. J. Gantzer, and W. J. Maier.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-222509.
Price codes: A04 in paper copy, A01 in microfiche.
June 1988. 49p, 8 fig, 4 tab, 42 ref.

Descriptors: \*Anabaena, \*Biodegradation, \*Biological wastewater treatment, \*Cyanide, \*Wastewater treatment, Ammonia, Biological treatment, Cyanobacteria, Hydrogen cyanide, Hydrogen ion concentration, Methane, Nitrogen fiving hectaria fixing bacteria

The study examined the ability of nitrogen-fixing Anabeana to biodegrade cyanide in batch reactors. Mixed second-order rate constants were obtained that described the biologically mediated decrease in cyanide for reactors containing initial cyanide concentrations of 3 ppm. For Anabaena cultures not previously exposed to cyanide, the rate constants were a function of pH. Faster rates of cyanide biodegradation were observed at higher nide biodegradation were observed at higher pH values. Anabaena cultures acclimated to the presence of cyanide had rate constants that were at least 10 times faster than rate constants for unacclimated cultures. Mixed second-order rate constants were also obtained foro the ability of nitrogenase, the enzyme normally responsible for nitrogen-fixation, to reduce hydrogen cyanide to methane and ammonia. In batch reactors with initial cyanide concentrations of 30 ppb, the rate constants for methane production were at least 10 times faster methane production were at least 10 times taster than expected based on literature values for nitro-gen fixation, suggesting that nitrogenase will pref-erentially use hydrogen cyanide as a substrate as compared to molecular nitrogen. Also, the rate constants for methane production were of the same order of magnitude as the rate constants for total cyanide removal, indicating nitrogenase as an im-portant mechanism for the biodegradation of trace concentrations of cyanide. The magnitude of the cyanide biodegradation rate constants suggests that the utilization of nitrogen-fixing cyanobacteria in the treatment of cyanide wastes can be a feasible process in some applications, ie., secondary or tertiary treatment at larger treatment facilities. (Author's abstract) W91-10245

DEVELOPMENT AND PRACTICAL TEST OF AN INSTRUMENT FOR EARLY RECOGNITION OF TOXIC INFLUENCES ON ANAERO-BIC WASTE WATER AND SLUDGE TREATMENT (ENTWICKLUNG UND PRAKTISCHE ERPROBUNG EINES GERATES ZUR FRU-HERKENNUNG SCHADLICHER EINFLUSSE AUF DIE ANAEROBE ABWASSER- UND SCHLAMMBEHANDLUNG). Hanover Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft und Abfalltechnik. For primary bibliographic entry see Field 7B.

For primary bibliographic entry see Field 7B. W91-10248

PRELIMINARY DATA SUMMARY FOR THE SOLVENT RECYCLING INDUSTRY. Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.

D. Anderson, and D. DiCianna.

D. Anderson, and D. Dicksma.

Available from the National Technical Information
Service, Springfield, VA. 22161, as PB90-126467.

Price codes: A05 in paper copy, A01 in microfiche.
Report No. EPA/440/1-89/102, September 1989. 79p, 1 fig, 28 tab, 25 ref. EPA Contract Nos. 68-03-3509, 68-03-3366, 68-03-3339.

Descriptors: \*Industrial wastewater, \*Recycling, \*Solvents, \*Wastewater treatment, \*Wastewater treatment facilities, Biochemical oxygen demand, Chemical oxygen demand, Costs, Iron, Lead, Oil, Organic carbon, Trichloroethane, Trichloroethene,

The Domestic Sewage Study, conducted by EPA in response to Section 3018(a) of the Resource in response to Section 3018(a) of the Resource Conservation and Recovery Act (RCRA), concluded that the quantity of hazardous wastes generated and discharged to publicly-owned treatment works (POTWs) by the solvent recycling industry was unknown. Spent solvents are recycled for reuse in fuel blends or as solvents at 210 facilities located throughout the Nation. The EPA Region with the largest number of recycles is Pacies V. with the largest number of recyclers is Region V, with 32% of the Nation's facilities. California, Illinois, and Ohio are the states with the largest numbers of recyclers. Solvent recyclers that recovnumbers of recyclers. Solvent recyclers that recover solvents for reuse are subject to effluent limitations guidelines for the organic chemicals industry. The average solvent recycler handles 0.8 million gallons of spent solvents annually. Industry process wastewater is characterized by high concentrations of conventional, nonconventional, metal, and organic pollutants. Typical industry process wastewater contains: BOD (76,300 mg/L); COD (145,000 mg/L); GI and grease (34,400 mg/L); TOC (111,000 mg/L); Fe (17 mg/L); Pb (17 mg/L); Zn (92 mg/L); acetone (6,590 mg/L); methylene chloride (833 mg/L); trichloroethane (82 mg/L); and trichloroethane (10 mg/L). Forty-three extractable and volatile organics were detected in L); and trichloroethane (10 mg/L). Forty-three extractable and volatile organics were detected in industry raw wastewaters. Of these, 40 had industry mean concentrations that exceeded 10 mg/L and 24 had concentrations that exceeded 10 mg/L. Cooling water discharges average 11,000 gpd/facility and contain significant levels of pollutants. Concentrations found in this industry are generally: BOD (919 mg/L); COD (3,500 mg/L); and TOC (75 mg/L). If treatment of cooling water is needed, stream stripping technology is available, which can be transferred to the solvent recycling industry. For treatment of cooling water, the average of the content of the cooling water is a very content of the cooling water in the average of the cooling water is a very cooling water. industry. For treatment of cooling water, the average plant would incur a capital cost of \$300,000 and an annual operating cost of \$35,000. (Lantz-W91-10252

PRELIMINARY DATA SUMMARY FOR THE TRANSPORTATION EQUIPMENT CLEANING

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5B. W91-10253

AEROBIC AND ANAEROBIC TREATMENT OF C.I. DISPERSE BLUE 79. Radian Corp., Milwaukee, WI.

D. A. Gardner, T. J. Holdsworth, G. M. Shaul, K. A. Dostal, and L. D. Betowski.

A. Dostal, and L. D. Betowski.

A vailable from the National Technical Information Service, Springfield, VA. 22161, as PB90-111642. Price codes: A06 in paper copy, A01 in microfiche. Volume I. Report No. EPA/600/2-89/051a, October 1989, 102p, 38 fig, 43 tab, 6 ref. EPA Contract No. 68-03-3371.

Descriptors: \*Activated sludge process, \*Azo dyes, \*Disperse blue, \*Wastewater treatment, Ac-tivated sludge, Anaerobic digestion, Effluents, Wastewater treatment facilities.

The fate of C.I. Disperse Blue 79, in a conventionally operated activated sludge process and an anany operated activated studge process and an an-aerobic sludge digestion system was determined in a pilot study conducted from November 1987 to February 1989 at the Milwaukee Metropolitan Sewerage District South Shore Wastewater Treat-ment Plant. The equipment operated during the

### **Group 5D—Waste Treatment Processes**

study included two continuous feed pilot-scale wastewater treatment systems, consisting of one control system and one experimental system. Each system included a primary clarifier, plug-flow aer-ation basin, secondary clarifier, and an anaerobic ation basin, secondary clarifier, and an anaerootic digester. Screened, raw wastewater, fed to the experimental treatment system, was dosed with a target concentration of 5 mg/L of active ingredient in the commercial formulation of C.I. Disperse Blue 79 did not complete the commercial formulation of C.I. Disperse Blue 79 did not complete the commercial formulation of C.I. Disperse Blue 79 did not complete the commercial formulation of C.I. Disperse Blue 79 did not complete the comp Blue 79. The addition of C.I. Disperse Blue 79 din not adversely affect the operation of the pilot activated sludge unit or the anaerobic digester. No evidence of C.I. Disperse Blue 79 degradation in the activated sludge systems was found. Mass balance calculations showed that on average, 86.5% of the dye contained in the feed to the system was present in the effluent streams. The average dye present in the ertuent streams. The average dye mass balance obtained around the system was 86.5%; the dye was partitioned in the effluent streams as follows: 3.6% in the primary sludge, 62.3% in the waste activated sludge, and 20.4% in the final effluent. The C.I. Disperse Blue 79 was degraded in the anaerobic digester. The dye con-centration was reduced from an average feed value centration was reduced from an average reed value of 566 mg/L to an average effluent value of 15.0 mg/L, or a 97.4% reduction. Possible degradation products of the dye were detected in the digester effluent, however, no positive identification or quantification of the compounds was accomplished. (Lantz-PTT) W91-10255

CHARACTERISTICS OF PILOT- AND FULL-SCALE HAZARDOUS WASTE INCINERATOR

Environmental Protection Agency, Cincinnati, OH.

For primary bibliographic entry see Field 5A. W91-10259

RESEARCH ON IMPROVEMENT OF ODOR PROBLEMS AND TREATMENT EFFICIENCY BY CONVERSION OF A CONVENTIONAL INTO A PURE OXYGEN ACTIVATED SLUDGE INIO A PURE OXYGEN ACTIVATED SLUDGE PLANT (UNTERSUCHUNGEN ZUR SANIER-UNG EINER BESTEHENDEN BELEEBUNG-SANLAGE DURCH UMRUSTUNG AUF SAUERRSTOFFBEGASUNG MIT DEM ZIEL EINER BESEITIGUNG VON GERUCHSEMIS-SIONEN UND VERBESSERUNG DER AB-LAUFQUALITAT).

L. Muller.

Available from the National Technical Information
Service, Springfield, VA. 22161, as TIBA 8882160.

Price codes: A06 in paper copy, A01 in microfiche.
Report No. BMFT-FB-02 WA 017, December
1985. 43p, 5 fig, 1 tab. English summary.

Descriptors: \*Activated sludge process, \*Karls-ruhe, \*Odor control, \*Oxygen, \*Wastewater treat-ment, Aeration, Biological treatment, Biological wastewater treatment, Germany, Sludge digestion, Sludge treatment, Trickling filters, Wastewater treatment facilities.

The municipal waste treatment plant in Karlsruhe, Germany, consists of an activated sludge plant Germany, consists of an activated sludge plant without primary sedimentation, but with thermal sludge conditioning, which caused severe odor problems right after its start. Between the planning stage (1974) and the start of the operation (in 1977), the public requirements for treatment efficiency were changed and could not be obtained by ciency were changed and could not be obtained by the plant. Between 1981 and 1984, the aeration system was changed using pure oxygen instead of air to fight the odor problems. In addition, trick-ling filters were installed for secondary biological treatments. By using pure oxygen aeration, the treatments. By using pure oxygen aeration, the very volatile substances were not stripped in the activated sludge plant, mitigating the odor problems. However, the consequence of this treatment was the creation of odor problems at the trickling filters. Pure oxygen aeration did not improve efficiency in the activated sludge plant, and costs for the plant were considerably higher than for a conventional plant. Sludge production in the plant conventional plant. Sludge production in the plant was somewhat smaller. (Author's abstract) W91-10260

TREATMENT OF SEWAGE SLUDGE: THER-MOPHILIC AEROBIC DIGESTION AND

PROCESSING REQUIREMENTS FOR LAND-FILLING.

Elsevier Applied Science, New York. 1989. 104p. Edited by A. M. Bruce, F. Colin, and P. J.

Descriptors: \*Aerobic digestion, \*Biological reatment, \*Landfills, \*Sludge, betteria, wastewater treatment, \*Landfills, \*Sludge, \*Sludge treatment, \*Thermophilic bacteria, \*Wastewater treatment, Regulations, Sludge dis-

Thermophilic aerobic digestion is important because it represents a relatively new and alternative method of both stabilizing and disinfecting sludge. Full-scale plants now exist in some countries. Processing requirements for sanitary landfilling is im-portant because 'quality' requirements for sludge that is destined for landfill disposal are becoming that is destined for landfill disposal are becoming increasingly stringent in many countries. New processing techniques are needed to meet these requirements. This volume contains the proceedings of a one-day workshop on thermophilic aerobic digestion and sewage sludge processing prior to landfilling that was held at the international Centre for Water (NANCIE), Nancy, France, on 25 November 1987. The two sessions included the 23 November 1967. The two sessions included the following presentations: fundamentals of thermophilic aerobic digestion; combined thermophilic aerobic and thermophilic anaerobic digestion of sewage sludge; thermophilic aerobic digestion in sewage studge; itermopinic aerobic ulgeston in the United Kingdom; practice and legislation con-cerning landfilling with sewage sludge in Europe; transformation of sewage sludge; ioperating mo-dalities for optimal treatment of landfill leachate; and experiences with limed sludge as a top cover for landfills. (See W91-10329 thru W91-10337) (Rochester-PTT) W91-10328

FUNDAMENTAL ASPECTS OF AEROBIC THERMOPHILIC BIODEGRADATION.

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Aquatic Sciences. G. Hamer.

O. Hamer. In: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 2-19, 7 fig. 1 tab, 17 ref.

Descriptors: \*Aerobic digestion, \*Biological wastewater treatment, \*Thermophilic bacteria, \*Wastewater treatment, Biodegradation, Polymers, Theory, Yeasts.

Aerobic thermotolerant and thermophilic biodegradation processes for waste sewage sludge treat-ment usually are discussed with excessive emphasis on process performance or without adequate con-sideration of the possibility for interactions among individual process parameters. Fundamental bio-technological studies were undertaken to consider such issues as biodegradation process feedstocks, such issues as biodegradation process feedstocks, waste sludge hygienization, biooxidation process stoichiometry, and microbial biomass solubilization and biodegradation. Experiments on the solubilization and biodegradation of yeast cells by bacterial action at thermophilic temperatures were conducted in a laboratory-scale bioreactor operating in the semi-continuous (fill and draw) mode. The mixed culture of process bacteria used was derived from a technical-scale, aerobic, thermophilic waste sewage sludge pretreatment process. Based on the results of studies of semicontinuous process operation, the following sequence of process events was suggested: (1) biodegradation of substrate microbe cell wall polymers results in the release of soluble cell components; (2) when suitable sub-strates become available, the activity of the process bacteria is enhanced and the soluble substrates are utilized preferentially; (3) accumulation of carboxylic acids, mainly acetic acid, occurs as a result of low dissolved oxygen concentration; (4) near exhaustion of the preferred soluble substrates is fol-lowed by the utilization of the lower molecular weight carboxylic acids produced earlier; and (5) hydrolysis of the remaining substrate microbe cell wall fragments and a fraction of the process bacteria occurs together with utilization of the higher molecular weight carboxylic acids. A mathematical model was developed based on these results. It

incorporates experimental results with hypotheses to yield sensible performance predictions. W91-10328) (Rochester-PTT) W91-10329

COMBINED, AEROBIC, THERMOPHILIC AND ANAEROBIC DIGESTION OF SEWAGE SLUDGE.

Technische Hochschule Darmstadt (Germany, F.R.).

IN: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 20-28, 5 fig.

Descriptors: \*Aerobic digestion, \*Biological wastewater treatment, \*Sludge digestion, \*Sludge treatment, \*Thermophilic bacteria, \*Wastewater treatment, Anaerobic digestion, Design criteria.

Combining aerobic-thermophilic and anaerobic di-gestion of sewage sludge can, depending on the use and the project, have various aims. Various designs are possible for combination plants, including dual aerobic-thermophilic/anaerobic stabilization and dual stabilization in the anaerobic/aerobic-thermo-philic combination. In the dual-stabilization combination with an upstream aerobic-thermophilic stage, it is particularly advantageous to use biogas stage, it is particularly advantageous to see ologia to generate electricity in 'block' power stations while simultaneously using the waste heat flows from the energy conversion in the process. A further heat exchange can transfer heat from the aerobically pre-heated sludge to the raw sludge via a sludge/sludge heat exchanger. The electricity derived from using biogas always is sufficient to drive all mechanical units shown in the current process layouts. Results from operational plants so far show that a biogas (gross energy) loss of some 15% must be expected. The combined processes sons, best suited to sewage treatment plants serving between 20,000 and considered are, for operational and economic reasons, pest sutted to sewage treatment plants serving equivalent populations between 20,000 and 200,000. The full-scale plants that have been installed so far show satisfactory results in terms of operational process objectives and associated operating costs. (See also W91-10328) (Rochester-PTT) W91-10330

DEVELOPMENT OF AN AEROBIC THERMO-PHILIC SLUDGE DIGESTION SYSTEM IN THE U.K.

Electricity Council Research Centre, Capenhurst

S. F. Morgan, and H. G. Gunson. S. F. Morgan, and R. G. Guisson. IR: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 29-38, 3 fig. 2 tab, 12 ref.

Descriptors: \*Aerobic digestion, \*Biological wastewater treatment, \*Farm wastes, \*Sludge digestion, \*Thermophilic bacteria, \*Wastewater treatment, Design criteria, Energy, England, Pilot plants, Temperature, Wales

The Electricity Council Research Center (England) has been interested in aerobic digestion since the early 1970s at the beginning of the development of the VO2 aeration system. While attemptment of the VO2 aeration system. While attempting to mix and aerate agricultural sludges and slurries with acceptable power efficiency, it became apparent from the rapid rise in reactor temperature that an opportunity existed for the parallel development of process and hardware. Consequently, the requirements of a viable aerobic thermophilic digestion (ATD) system; high oxygen transfer, high power efficiency, and excellent mixing became design objectives. Pilot studies were conducted at positive (Wales) and ultimately. were conducted at Ponthir (Wales) and ultimately these led to the construction of a 420 cu m reactor designed to process up to 5 tones dry solids per day, to achieve a temperature lift of 60 C, to day, to achieve a temperature lift of or C, to render sludge stable and pasteurized, and to lose significant water volume by evaporation. The system has a low capital cost; the process has an acceptable energy cost; and the process offers future opportunities for the export of heat energy. (See also W91-10328) (Rochester-PTT)

### Ultimate Disposal Of Wastes-Group 5E

W91-10331

OTHER INVESTIGATIONS OF THERMOPHI-LIC AEROBIC DIGESTION IN THE UK. Water Research Centre, Stevenage (England).

water Research Centre, Stevenage (England).

A. M. Bruce.

IN: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 39-43, 2 fig, 3 ref.

Descriptors: \*Aerobic digestion, \*Biological wastewater treatment, \*England, \*Sludge digestion, \*Sludge treatment, \*Thermophilic processes, Comparison studies, Design criteria, Energy, Performance evaluation, Sludge stabilization.

Thermophilic aerobic digestion (TAD) is being investigated in various studies in the United Kingdom. Two studies are currently being undertaken by the Water Research Centre (England), one involving a direct comparison of TAD and mesophic aerobic digestion (AD) at a sewage works serving a population of 50,000 and the other evaluating the suitability of TAD as a stabilization process for sludges at small isolated works. The digestion tanks to be used in the comparison studies are tanks to be used in the comparison studies are designed so that both can be converted to either designed so that both can be converted to either the AD or the TAD process to provide long-term flexibility. Part of the study will be the energetics of the two processes, aimed at determining what levels of energy can be recovered. Small sewage works operate much like larger works, but operworks operate much like larger works, but oper-ational problems may occur more often at smaller works because they lack a permanent staff. Be-cause the TAD process is much simpler, it is more suited than AD for these small isolated works. The TAD plant to be tested for rural use has a 21 cu m capacity. An estimate of the capital and operating costs of the small TAD unit indicates that it is considerably more economical than an aerobic digestion system designed to serve the same population. However, a period of operation of at least 1 yr will be needed to assess the true operating and maintenance costs of the small TAD plant. (See also W91-10328) (Rochester-PTT) W91-10332

LANDFILLING OF SEWAGE SLUDGE: PRACTICE AND LEGISLATION IN EUROPE. Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

For primary bibliographic entry see Field 5E. W91-10333

LANDFILL LEACHATE: OPERATING MO-DALITIES FOR ITS OPTIMAL TREATMENT.

Basilicata Univ., Potenza (Italy). G. Boari, and I. M. Mancini.

O. Doutt, and I. M. Mancini. IN: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 80-91, 5 fig, 2 tab, 23 ref.

Descriptors: \*Biological wastewater treatment, \*Land disposal, \*Landfills, \*Leachates, \*Sludge disposal, \*Wastewater treatment, Anaerobic digestion, Biogas, Leachate recirculation, Methanogenesis, Self-purification, Sludge.

Many types of wastes (refuse, sludge, and ash) often are disposed of in sanitary landfills. Degradation of wastes consists of three stages: the achievement of a stable third stage of methanogenesis, with consequent leachate self-depuration, is delayed by hydrolysis and acidification of easily biodeseedable condenses. degradable substances, thus requiring the appropri-ate operating modalities to speed up the first two stages. Sludge addition, leachate recirculation, and layer formation were investigated as means of ob-taining a faster waste stabilization, less leachate, and better leachate quality. Co-disposal of a maxiand orter reachate quanty. Co-usposa of a maximum 30% by volume of sewage sludge cakes with municipal solid wastes has a positive effect in enhancing biochemical processes. The establishment of thermophilic conditions requires careful control of moisture content. This can be done by recirculating leachate, the amount of which is reduced by evaporation under favorable environmental condi-

tions. Leachate recirculation through the landfill allows the anaerobic processes, which reduce its polluting load, to commence much sooner. Placement of layers of appropriate thickness improves leachate characteristics. The excess leachate can be leachate characteristics. The excess leachate can be treated in several ways. Anaerobic co-digestion with municipal sludge yield biogas and dilution of biorefractory organic compounds. Further pilot-scale investigations are needed before scaling up to industrial installations. (See also W91-10328) (Rochester-PTT)
W91-10336

EXPERIENCES WITH LIMED SLUDGE AS A TOP COVER FOR LANDFILLS.

Univ. of For primary bibliographic entry see Field 5E. W91-10337 (Sweden).

SEWAGE AND SEWAGE SLUDGE TREAT-

MENT.
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
J. N. Lester.
Cause: Effects and Control. Royal

J. N. Lester. IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 33-62, 11 fig, 3 tab, 12 ref.

Descriptors: \*England, \*Sludge disposal, \*Sludge treatment, \*Wales, \*Wastewater disposal, \*Wastewater treatment, \*Water reuse, Energy costs, Ocean dumping, Pretreatment of wastewater, Primary wastewater treatment, Secondary wastewater treatment.

The sewage from approximately 44 million people in England and Wales is treated by conventional wastewater treatment processes, that from about a further 6 million people is discharged without treatment to the sea and some 1 to 2 million people are not connected to the sewage system. It is now the objective of sewage treatment in many parts of England to produce a sewage effluent which after varying degrees of dilution and self purification is suitable for abstraction for treatment to produce a solution of abstraction of treatment of produce a potable supply. Conventional sewage treatment is a three stage process including preliminary treat-ment, primary sedimentation, and secondary treat-ment. In addition, some form of sludge treatment is ment. In addition, some form of sludge treatment is frequently employed, typically anaerobic digestion. The main aims of sludge treatment are to make it easier and cheaper to dispose of the sludge consistent with minimizing any nuisance or adverse effects on the environment generally. The most convenient and economical method of disposal at any given site depends on a number of factors. Recently the cost of energy has been a major concern. Treatment of sludge is frequently influenced by the final disposal option selected (See enced by the final disposal option selected. (See also W91-10406) (White-Reimer-PTT) W91-10409

TREATMENT OF TOXIC WASTES, Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.

A. James. IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 63-81, 9 tab, 6 ref.

Descriptors: \*England, \*Environmental quality, \*Hazardous materials, \*Hazardous waste disposal, \*Sludge disposal, \*Toxic wastes, \*Wastewater treatment, Biodegradation, Case studies, Ecological effects, Path of pollutants, Toxicity.

The presence of toxic substances in wastewaters has always been a matter for concern. This concern has become much more pressing with the intentional or unintentional release of an ever larger variety of substances into the environment. The spectrum of problems that have arisen in attempting to control the toxicity problem include:
(1) assessment of environmentally safe concentrations—subtle, sublethal effects and chronic effects tions—subtle, subtenal effects and efform effects may impair ecological success at concentrations well below those causing death; and (2) assessment of biodegradability—persistence of toxins in the environment. Because of these problems the treat-

ment and disposal of toxic wastewaters has re-mained on an empirical level. An overview is presented covering the following topics: sources of toxic wastewaters; collection problems; pretreat-ment; primary and secondary treatment; sludge treatment and disposal; direct disposal; and case studies involving tannery wastes, metal-processing wastes, and recovery techniques. (See also W91-10406) (White-Reimer-PTT) W91-10410

### 5E. Ultimate Disposal Of Wastes

LANDFILL LEACHATE RECIRCULATION: EFFECTS ON VEGETATION VIGOR AND CLAY SURFACE COVER INFILTRATION. Guelph Univ. (Ontario). Dept. of Land Resource Science.

For primary bibliographic entry see Field 3C. W91-09330

WATER-SOLUBLE FRACTIONS OF HEAVY METALS DURING COMPOSTING OF MUNIC-IPAL SOLID WASTE.

Udine Univ. (Italy). For primary bibliographic entry see Field 5B. W91-09335

TRACE METAL MOVEMENT IN AN AERIC OCHRAQUALF FOLLOWING 14 YEARS OF ANNUAL SLUDGE APPLICATIONS. Department of Agriculture, St. Paul, MN. For primary bibliographic entry see Field 5B. W91-09341

PROPERTIES OF CEMENT MADE FROM

SLUDGE.

Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering. For primary bibliographic entry see Field 8G. W91-09388

PCB, PCDD AND PCDF CONCENTRATIONS IN SOILS FROM THE KIRK SANDALL/EDENTHORPE/BARNBY DUN AREA. Diverse Analyticals Ltd. Manchester (England). For primary bibliographic entry see Field 5B. W91-09429

BIODEGRADABILITY AND INHIBITORY THRESHOLD CONCENTRATION OF SOME DISINFECTANTS.

Henkel K.G.a.A., Duesseldorf (Germany, F.R.). For primary bibliographic entry see Field 5B. W91-09439

HYDROLOGICAL, METEOROLOGICAL AND GEOHYDROLOGICAL DATA FOR AN UNSATURATED ZONE STUDY NEAR THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO-1987.

Geological Survey, Idaho Falls, ID. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-09499

TRITIUM IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-09553

NATURAL PROCESSES FOR TERTIARY TREATMENT OF MUNICIPAL WASTEWATER COUPLED WITH SHALLOW GROUND-WATER DISCHARGE IN A SALTWATER MARSH ENVIRONMENT - A CASE STUDY. Hydro Systems, Inc., Berlin, MD. For primary bibliographic entry see Field 5D. W91-09641

### Group 5E-Ultimate Disposal Of Wastes

NEW APPROACHES FOR THE GENERATION OF GROUNDWATER QUALITY STANDARDS -THE USE OF CONSENSUS TECHNIQUES IN REVISING VIRGINIA'S GROUNDWATER STANDARD.

Virginia Univ., Charlottesville. Div. of Urban and Environmental Planning. For primary bibliographic entry see Field 5G. W91-09653

SLUDGE MANAGEMENT: CAPITAL IM-PROVEMENTS.

Professional Services Group, Inc., Houston, TX. S. Kruger, P. Becker, and D. Merrill. Water Engineering and Management WENMD2, Vol 138, No. 2, p 26, 28, February 1991.

Descriptors: \*Cost analysis, \*Incineration, \*Land disposal, \*Sludge cake, \*Sludge disposal, \*Sludge treatment, Activated sludge, Aerobic digestion, Brockton, Capital costs, Costs, Injection, Iowa, Lime, Massachusetts, Oklahoma, Oklahoma City, Polymers, Sioux City, Sludge drying, Sludge stabilization, Transportation, Wastewater treatment.

Three examples show how municipalities used innovative technology to solve divergent sludge handling and disposal problems. The 18-mgd ad-vanced wastewater treatment facility at Brockton, Massachusetts increased the efficiency of its multiple-hearth sludge incinerator operations. Inciner pte-nearth studge incinerator operations. Incinera-tor throughput doubled from approximately 5-7 dry tons of sludge per day to 10-14 dry tons per day. Average costs for sludge incineration were reduced by approximately 75%. Incinerator ash volume was reduced by 66%. Sioux City, Iowa has been land-applying liquid sludge to farmland through subsurface injection since 1985. Sioux City has a 30-mgd activated sludge wastewater treat-ment plant. A tank feeds three sludge injector units at the sites, which are calibrated to provide an even, uniform, and continuous application rate at various gear ranges and engine speeds. Since 1982, Oklahoma City has applied liquid sludge through subsurface injection. With an investment of \$1 subsurface injection. With an investment of \$1 million, the disposal practice was changed to a cake sludge system, saving costs by reducing the amount of water transported to application sites. Aerobic digesters were able to be removed from Actionic algesters were able to be removed from service, saving \$700,000 in electrical costs per year. The change to a postdewatering lime stabilization system netted annual polymer savings of \$100,000, and reduced the annual cost for lime by \$120,000. (Doria-PTT) W91-09775

METHODS FOR SELECTION AND HYDRO-LOGIC DESCRIPTION OF POTENTIAL LAND-FILL SITES IN SOUTHEASTERN SAN DIEGO COUNTY, CALIFORNIA. Geological Survey, San Diego, CA. Water Re-

sources Div. C. A. Kaehler.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4021, 1990. 73p, 16 fig, 12 tab, 39 ref.

Descriptors: \*Groundwater movement, \*Sanitary landfills, \*Site selection, \*Solid waste disposal, \*Water pollution prevention, Aquifer testing, Geohydrology, Manzanita Indian Reservation, Vallehydrology, Manzanita Indian Reservation, cito Valley, Water level, Water quality.

Methods for geohydrologic appraisal of potential landfill sites were developed and tested using southeastern San Diego County as a study area. Phase 1 involved the selection and preliminary evaluation of a number of potential landfill sites, and phase 2 involved the collection of geologic and phase 2 involved the conection or georgia-and hydrologic data to aid in the more detailed evaluation of two potential sites. Methods applied in phase 1 include the complication of topographic, geologic, and hydrologic information from existing sources and from limited site visits, and the use of vertical electrical-resistivity soundings to provide additional information about subsurface geology. In phase 2, data were collected from existing wells and springs, but new data also were collected by drilling test holes and test wells, measuring water levels and conducting aquifer tests on the wells,

and collecting and analyzing water samples. The phase 2 studies were useful in determining basic information about the geohydrologic conditions at the two selected sites, including depth to water, estimates of horizontal permeabilities, and possible effects of a fault on groundwater movement. (USGS)

EFFECT OF SPRAY IRRIGATION OF TREAT-ED WASTEWATER ON WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM, REEDY CREEK IMPROVEMENT DISTRICT, CEN-TRAL FLORIDA.

Geological Survey, Orlando, FL. Water Resources

E. H. German.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4174, 1990. 43p, 24 fig, 4 tab, 17 ref. USGS Project No. FL-388.

Descriptors: \*Water pollution sources, \*Wastewater irrigation, \*Water reuse, \*Path of pollutants, \*Florida, \*Reedy Creek Improvement District, Groundwater movement, Groundwater

Spray irrigation of ornamental plant stock is used Spray irrigation of ornamental plant stock is used to dispose of a part of the treated wastes from the Walt Disney World complex within the Reedy Creek Improvement District, in Central Florida. The irrigation quantities for October 1980 through September 1984 were equivalent to about 41 inches of rainfall/year. A 62 acre part of the spray irrigation area was selected for study of the hydrologic system and the effects of the wastewater application of the spray of the sp system and the tribers of the waster quality. An aquifer test indicated that transmissivity of the surficial aquifer system is about 500 sq ft/day. Vertical movement in the surficial aquifer system is limited, and most of the recharge to the surficial anuted, and most or the recharge to the surficial aquifer system in the study area probably moves laterally into surroundings canals. Most of the nitrogen in the water of the surficial aquifer system is in the organic and ammonia forms. However, there may be a significant part of intervention. be a significant part of nitrate nitrogen beneath wastewater application areas where the water table is at least 8 ft below land surface. Phosphorus concentration along one end of the study area exceeded that in the wastewater. The reason for the high phosphorus concentrations is not known. (USGS) W91-09844

HISTORY OF GROUND-WATER CONTAMINATION AND SUMMARY OF GROUND-WATER INVESTIGATIONS THROUGH 1985 AT FOUR INDUSTRIAL SITES, LOGAN TOWNSHIP, NEW JERSEY.
Geological Survey, Trenton, NJ. Water Resources

For primary bibliographic entry see Field 5B. W91-09848

DIFFICULTIES CONFRONTING AN AGRI-CULTURAL PESTICIDE WASTE COLLEC-TION PROGRAM IN WISCONSIN.

Wisconsin Univ.-River Falls. Dept. of Plant and Farth Sciences.

R. M. Kozak, and E. Hass. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 271-272, 1990. 1 ref.

Descriptors: \*Agricultural chemicals, \*Hazardous waste disposal, \*Nonpoint pollution sources, \*Pesticides, \*Water pollution prevention, \*Wisconsin, Institutional constraints, Landfills, Permits, Regulations, Rural areas, Waste collection.

The Agricultural Clean Sweep Committee was formed to investigate the feasibility of establishing an agricultural pesticide waste collection program in two rural Wisconsin counties. Three problems were encountered: (1) To keep hazardous waste out of landfills, Wisconsin regulates such wastes in any amount. Hence, a farmer who decides to bring farm pesticide waste to a central collection point is considered a small-quantity hazardous waste gen-

erator and must be licensed or permitted as a hazardous waste hauler. (2) The quantity of farm pesticide waste is unknown. (3) As a consequence, without good estimates of potential collection volume, it is difficult to obtain financing for collection programs. Several remedial options are being considered: (1) Collecting waste via a 'milkrun' operation, in which the farmer would maintain generator status and waste would be collected at generator status and waste would be confected at individual farms; (2) issuance of a temporary waiver; (3) a mandatory liquid shuttle system whereby only the amount of chemical needed by a farmer would be metered from a mobile tank; (4) pesticide containers that would be returnable to the manufacturer; and (5) an environmental assess-ment at the time of each land transfer which would certify that any and all hazardous waste on the property had been disposed of properly. (Feder-PTT)

W91-09896

WASTEWATER DISPOSAL AT FRUIT AND VEGETABLE PACKING FACILITIES IN DADE COUNTY, FLORIDA.

Department of Environmental Resources Management, Miami, FL. Agricultural Waste Program. D. F. Howard, S. M. Alspach, and N. D. Stevens. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 274-275, 1990.

Descriptors: \*Agricultural wastes, \*Florida, \*Food-processing wastes, \*Groundwater pollution, \*Wastewater disposal, \*Water pollution prevention, Dade County, Fruit crops, Permits, Regulations, Vegetable crops, Water quality standards, Water quality Water supply.

Agricultural impacts on groundwater supplies are of particular interest in Dade County because the or particular interest in Dade County occause the sole source of drinking water is a surficial, porous limestone aquifer with a documented history of vulnerability to pollution. The county has implemented a comprehensive program of groundwater protection, including land use restrictions, permitting, inspection and enforcement of potential sources of pollution, water quality monitoring and educational efforts. Until recently this program focused primarily on urban areas and municipal drinking water wellfields and essentially over-looked agriculture. A May 1988, a permitting orditooked agricultura. A may 1908, a perimiting ordi-nance requires agricultural waste generators, in-cluding packing facilities, to obtain annual operat-ing permits. It also subjects facilities to regular inspections for compliance with best management practices and water quality standards and require payment of annual fees to defray inspection, laboratory and administrative costs. Effluent analyses at 18 or 38 tested fruit packing operations have revealed the presence of contaminants at concen-trations exceeding water quality standards. Memtrations exceeding water quality standards. Mem-bers of the packing industry are working independ-ently or in collaboration with the Cooperative Extension Service and the University of Florida to identify cost-effective methods of wastewater treatment. (Feder-PTT)

APPLICATION OF DISTILLERY WASTE AN-AEROBIC DIGESTER EFFLUENT TO ST. AU-GUSTINEGRASS.

Southeast Kansas Branch Experiment Station, Par-

D. W. Sweeney, and D. A. Graetz.

Agriculture, Ecosystems and Environment AEENDO, Vol. 33, No. 4, p 341-351, 1991. 7 tab,

Descriptors: \*Effluents, \*Grasses, \*Wastewater utilization, \*Industrial wastes, Anaerobic digestion, St Augustinegrass, Growth, Elemental uptake, Potassium, Aluminum, Manganese, Sodium, Crop yield, Groundwater quality.

Effluent that results from methane anaerobic digestion needs to be disposed of or utilized. The objec-tive of this glasshouse study was to examine the effect of rum distillery anaerobic digester effluent application rate on St. Augustinegrass (Stenotaphum secundatum Kuntze) growth and elemental uptake to determine the feasibility of land applica-

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

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tion. The initial application rates were 0, 0.22, 0.44, and 0.88 cm of the liquid effluent per week, equivalent to 0, 22, 44, and 88 g total solids (TS) per pot, respectively, for the first 4 months of the study. Because of apparent plant stress, effluent application was eliminated for the high application rate during the final 4 months of the experiment. Since both of the two higher rate treatments received a during the final 4 months of the experiment. Since both of the two higher rate treatments received a total of 88 g TS per pot, treatments were designated as 0-(8mo), 44-(8mo), 88-(8mo), and 88-(4mo) to denote the time frame in which the total amount of effluent was applied. In general, uptake of measured elements increased with the increased dry matter production. However, yield differences in K, Al, and Mn uptake appeared larger than observed with yield differences. Soil concentrations of elements measured were increased with effluent of elements measured were increased with effluent applications especially K and Na. Results suggest that the lowest effluent application rate, 44-(8mo) which is equivalent to 0.22 cm/week, may result in acceptable St. Augustinegrass growth. However, the apparent elemental buildup in the soil and the potential adverse effects on groundwater quality suggest that even lower rates may be necessary for longer-term continuous disposal of the distillery waste anaerobic digester effluent. (Medina-PTT) W91-09931

EFFECT OF BORON AND COPPER CONTAMINANTS IN POULTRY MANURE ON THE GROWTH OF THE COMMON MUSHROOM, AGARICUS BISPORUS.

NSW Agriculture & Fisheries, P.M.B. 10, Rydalmere, N.S.W. 2116, Australia.

G. C. Cresswell, N. G. Nair, and J. C. Evans.

Australian Journal of Experimental Agriculture AAAHAN, Vol. 30, No. 5, p 707-712, 1990. 7 fig, 1 tab, 19 ref.

Descriptors: \*Boron, \*Compost, \*Copper, \*Fungi, \*Plant growth, \*Waste utilization, Crop production, Fertilizers, Inhibition, Manure, Poultry, Tox-

The toxicity of B and Cu to cultivated mushrooms was tested in 2 experiments. The growth of mushroom mycelium (Agaricus bisporus) on potato dextrose agar in vitro was inhibited by additions of B as H3BO3 and Cu as CuSO4.5H2O. B was more inhibitory than Cu to mycelial growth. Addition of B to compost at spawning decreased sporophore (mushroom) production and increased B concentrations in the sporophore. B added at 35 mg/kg of fresh compost gave a 10% yield reduction which fresh compost gave a 10% yield reduction which was associated with a sporophore tissue B concen-tration of 170 mg/kg dry weight. Addition of Cu to the compost had no effect on the final yield of mushrooms but increased Cu concentrations in the sporophores. B added at 5, 10 and 20 mg/kg and Cu at 10 mg/kg of fresh compost stimulated sporo-Cu at 10 mg/kg of fresh compost stimulated sporo-phore growth at first flush but this was not evident in total mushroom yield from all flushes. There was a significant negative linear effect of mush-room B and Cu at harvest 1 (day 1) on the change in tissue B or Cu from harvest 1 to 6 (day 17), suggesting that tissue B was buffered around 7 mg/kg and Cu around 73 mg/kg. The levels of B and Cu which are normally contributed to mushroom compost from poultry litter are unlikely to cause significant losses in mushroom production. (Au-thor's abstract) thor's abstract) W91-09950

RESPONSE OF TALL FESCUE TO COMPOST-ED SEWAGE SLUDGE USED AS A SOIL AMENDMENT.

Nevada Univ., Reno. Dept. of Plant Science. D. A. Devitt, R. L. Morris, and D. C. Bowman. Journal of Plant Nutrition JPNUDS, Vol. 13, No. 9, p 1115-1139, 1990. 2 fig. 5 tab, 15 ref.

Descriptors: \*Compost, \*Fescues, \*Land disposal, \*Sludge disposal, \*Sludge utilization, \*Soil amendments, Clay soils, Desert soils, Loam, Minerals, Plant growth, Turf grasses.

A pot experiment was conducted in the green-house to investigate the effects of composted sewage sludge as a soil amendment on growth and mineral composition of Mustang tall fescue (Fes-tuca arundinacea). Three desert soils (loamy sand,

sandy loam, clay) were amended with two different composted sewage sludges (city and county) at rates of 0, 7.5, 15, 30, and 60% by volume. Tall fescue was grown in the amended soils for four months. Growth rates, measured as harvested clippings, increased with sludge loading rate and also with clay content of the soil. Higher growth rates were maintained with the city as compared to the county sludge, although for both sources growth declined for most treatments after nine weeks. Turf color ratings and percent N in the tissues increased with sludge loading rate and were highly correlated. Tissue analysis showed a varied response between soil types. The results indicate that composted municipal sludge can be used effectively as a soil amendment in turfgrass production. Sludge improved soil moisture holding capacity and provide adequate nutrients for healthy turf growth, comparable to normal fertilizer applications. (Author's abstract) sandy loam, clay) were amended with two differthor's abstract)

SAMPLING STRATEGIES FOR ASSESSING HYDRAULIC CONDUCTIVITY AND WATER-CONDUCTING VOIDS IN SAPROLITE. North Carolina State Univ., Raleigh. Dept. of Soil

M. J. Vepraskas, M. T. Hoover, and J. Bouma. Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 165-170, January/February 1991. 4 fig, 3 tab, 19 ref.

Descriptors: \*Experimental design, \*Hydraulic conductivity, \*Liquid wastes, \*On-site waste dis-posal, \*Sampling, \*Saprolites, \*Waste disposal, Bedrock, Dyes, Statistical analysis, Tracers, Void

A saprolite's saturated hydraulic conductivity (Kas aprofine's saturated hydraunic conductivity (Resalt) and types of water-conducting voids must be known to assess its suitability for liquid waste disposal. Optimum numbers of pits and numbers of samples per pit needed to estimate a saprolite's K-sat and volume percentages of water-conducting macrovoids and groundmass (microvoids) were inusstituted. These sits users due across a Sab assess vestigated. Three pits were dug across a 5-ha area of expose B horizons and saprolite (2-m depth), and undisturbed cores were collected from each pit. The K-sat was measured for each core, and water-conducting voids were dyed. Volume perwater-conducting voids were dyed. Volume per-centages of water-conducting (dyed) macrovoids (e.g., root channels with diameters > or = 0.1 mm) and water-conducting groundmass were de-termined from thin sections. Mean values for sa-prolite K-sat and volume percentages of water-conducting macrovoids and groundmass were 0.25 cm/h and 1.1 and 47.9%, respectively. In order to minimize both the variance of each mean value and the time required for each wein value and the time required for analysis, it was most efficient to collect only one core per pit. The most efficient number of pits depended on the desired size of the confidence interval and the property of interest. A 95% confidence interval for saprolite K-sat that was within 10% of the true mean would require over 700 pits per 5 ha, while an estimate of the percentage of water-conducting groundmass percentage of water-conducting groundmass would require only 10 pits per 5 ha. Increasing the width of the 95% confidence intervals to be within 50% of the means reduced the required number of pits for these properties to 28 and 1, respectively. (Author's abstract) W91-09966

COMPUTERIZATION OF THE DECISION-MAKING FRAMEWORK.
ASCI Corp., Duluth, MN.
For primary bibliographic entry see Field 6A.
W91-10066

REVISED PROCEDURAL GUIDE FOR DESIG-NATION SURVEYS OF OCEAN DREDGED MATERIAL DISPOSAL SITES.

LGL Ecological Research Associates, Inc., Bryan, TX. For primary bibliographic entry see Field 5G. W91-10068

TOXICITY EVALUATIONS FOR HAZARDOUS WASTE SITES: AN ECOLOGICAL ASSESSMENT PERSPECTIVE.

NSI Technology Services Corp., Corvallis, OR. Environmental Research Lab. G. Linder, J. C. Greene, L. Kapustka, C. L.

Bartels, and M. Bollman. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134271. Price codes: A03 in paper copy, A01 in microfiche, Report No. EPA/600/D-89/220, 1989. 17p, 4 fig, 19 ref. 2 append.

Descriptors: \*Data acquisition, \*Ecological effects, \*Hazardous wastes, \*Toxicity, \*Toxicology, \*Waste disposal, Bioassay, Biological studies, Data interpretation, Environmental impact, Field tests, Kriging, Statistical analysis, Sublethal effects.

Ecological assessments for hazardous waste sites assessments for nazardous waste sites should include acute toxicity tests as well as short-term tests which measure biological endpoints other than death. Toxicity and field assessment methods may be assembled into 'tool boxes' which reflect not only the site-specific demands made by the ecological assessment process, but the continu-ing progress in methods development. Toxicity assessment tools may yield information regarding acute biological responses elicited by site samples as well as suggest longer-term biological effects (e.g., genotoxicity or teratogenicity) potentially associated with subacute and chronic exposures to complex chemical mixtures characteristics of hazcomplex chemical mixtures characteristics of hazardous waste sites. Toxicity tests, however, are but one component of an ecological assessment for a hazardous waste site; field components must be given equal regard during the early phases of site evaluation. This becomes particularly important when field sampling is considered, since integration of toxicity assessments (be those in situ or laboratory-generated) and field assessments requires a well designed sample plan to establish linkages among toxicity, site sample chemistry and adverse ecological effects, if apparent. Spatial standards ecological effects, if apparent. Spatial standards expected and success the sample chemistry and adverse ecological effects, if apparent. Spatial standards expected and success the sample chemistry and adverse ecological effects, if apparent. Spatial standards expected and success the sample chemistry and adverse ecological effects, if apparent. linkages among toxicity, site sample chemistry and adverse ecological effects, if apparent. Spatial statistic techniques like kriging are finding increased applications in linking toxicity with other elements of site evaluation (e.g., field sample chemistry). Through kriging, for example, areal distributions for site-specific toxicity and chemistry data sets may be derived, then 'maps' of site sample toxicity and chemistries overlaid. Patterns of coincidence apparent in these distributions may then suggest linkages among toxicity, site contaminants, and adverse ecological effects. (Author's abstract)

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES FOR ISO-LATION OF HIGH-LEVEL RADIOACTIVE WASTE--CHARACTERIZATION OF THE SON-ORAN REGION, ARIZONA.

For primary bibliographic entry see Field 2F. W91-10076

USE OF FLEXIBLE MEMBRANE LINERS IN HAZARDOUS AND NONHAZARDOUS LAND-

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. R. Landreth.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134412. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/234, 1989. 13p, 5 fig, 4 tab, 13 ref.

Descriptors: \*Landfills, \*Membrane liners, \*Waste disposal, \*Water pollution control, Durability, Hazardous wastes, Leachates, Light effects, Liners, Materials testing, Membranes, Stress.

The US EPA was mandated by the U.S. Congress to develop standards for the management of both hazardous and nonhazardous waste in a manner that would protect human health and the environthat would protect human heatth and the environ-ment. Use of a double, composite flexible mem-brane liner (FML) has been found to best protect the surrounding environment. Synthetic landfill liners are made of polymers, i.e., natural or syn-thetic compounds of high molecular weight. Per-formance of the liner is dependent on several fac-tors that must be considered in selecting the proper

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liner materials. For membranes with and without fabric reinforcement, there are tests for analytical properties (volatiles, extractables, ash, specific properties (volatiles, extractables, ash, specific gravity, including thermal analysis); for physical properties, (tear resistance, hydrostatic resistance, seam strength, ply adhesion); and for the effects of the environment and aging (ozone cracking, environmental stress cracking, low temperature, tensile properties at high temperatures, dimensional stability, air-oven aging, water vapor transmission, water absorption, immersion in standard liquids and in waste liquids, soil burial, and outdoor exposure). When FMLs are employed in landfills, design elements such as the following, must be considered: minimum technology guidance, stress considered: minimum technology guidance, stress considerations, structural details, and panel fabrica-tion. Because certain FML materials deteriorate over time when exposed to chemical constituents of leachate, the kind and quality of leachate that a site will generate must be predetermined and the liner material must be selected accordingly. Mem-branes are continually being improved while the branes are continually being improved while the waste streams are changing resulting in a need to evaluate the chemical resistance of the membrane for each specific site. The five steps that ensure quality construction for FMLs are: (1) responsibility and authority; (2) construction quality assurance (CQA) personnel qualifications; (3) inspection activities; (4) seam sampling strategies; and (5) documentation. The durability of FMLs is the major consideration in determining the total life of an FML-lined landfill. Under the ideal conditions of no sunlight, oxygen, or stress, a properly formulated, compounded, and manufactured FML will last intact indefinitely. Field conditions are, however, not ideal. Because it's not possible to directly ever, not ideal. Because it's not possible to directly measure an FML's life, the various physical, mechanical, and chemical factors that contribute to its degradation must be considered. (Lantz-PTT) W91-10077

## WASTE CONTAINMENT SYSTEMS: CON-STRUCTION, REGULATION AND PERFORM-

ANCE.

Proceedings of a symposium sponsored by the American Society of Civil Engineers, San Francis-co, CA, November 6-7, 1990. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. 266p. Edited by Rudolsh Represents dolph Bonaparte.

Descriptors: \*Clay liners, \*Drainage systems, \*Landfills, \*Leaching, \*Liners, \*Waste disposal, \*Water pollution prevention, Bentonite, Case studies, Earthworks, Fly ash, Hazardous waste disposal, Leachates, Performance evaluation, Regulations, Waste management, Zeolites.

The Committee on Soil Improvement and Geosynthetics and the Committee on Soil Properties of the ASCE Geotechnical Engineering Division held a three-session symposium on recent develop-ments in construction, regulation, and performance of waste containment systems at the November 1990 ASCE National Convention in San Francis-co, California. Geotechnical engineers are increasingly involved in the design and construction of waste containment systems that utilize soil and geosynthetic liners and drainage layers. This book presents twelve papers on the construction, regulapresents twerve papers of in the construction, regula-tion, and performance of waste containment sys-tems. The papers cover topics such as: (1) federal and state landfill containment regulations; (2) per-formance evaluations of earthen liners; (3) field behavior of double-liner systems; (4) long-term properties of earthen and geomembrane liners; and (5) detailed case studies of earthen liner perform-ance. It also discusses construction quality control of earthen and geomembrane liners, field verifica-tion of earthen liner hydraulic conductivity, and the use of waste-attenuating soil materials, such as bentonites, zeolites, organically modified clays, and fly ash, in earthen liners. (See W91-10151 thru W91-10151) (Geiger-PTT) W91-10150

### LANDFILL CONTAINMENT SYSTEMS REGU-

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. R. E. Landreth.

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 1-13. 2 fig, 15 ref.

Descriptors: \*Geosynthetics, \*Geotextiles, \*Landfills, \*Liners, \*Materials engineering, \*Regulations, \*Water pollution prevention, Design criteria, Drainage systems, Hazardous waste disposal, Leachates, Quality control, Waste disposal, Waste

The Resource Conservation and Recovery Act hazardous waste containment regulations prescribe performance standards rather than design stand-ards or recommendations. The EPA has compiled source documents to aid the designer, permit re-viewer, and owner/operator with each element of the design, construction, and approval process. Geosynthetic materials are being increasingly used in the design and construction of containment sys-tems. Geomembranes are required as the mainstay of the low-permeability barriers in liners and covers for landfills. Geonets may be substituted for high-permeability soil in drainage layers in the cover and between the liners in a double-liner system. Geotextiles are frequently used to separate layers to prevent material encroachment from one layer into another or to prevent abrasion damage. Plastic pipes are used to quickly carry off liquid from drainage layers. Geosynthetic materials must be carefully selected, tested, and installed to assure that they will carry out their intended functions indefinitely. Otherwise, they are subject to a variety of deterioration mechanisms, such as chemical dissolution, creep under pressure, or rupture under physical stresses. All of these can be prevented by materials testing and careful attention to detail in design, construction, and construction quality assurance. (See also W91-10150) (Geiger-PTT) W91-10151

## REGULATION, CONSTRUCTION AND PERFORMANCE OF CLAY-LINED LANDFILLS IN

Wisconsin Dept. of Natural Resources, Madison. For primary bibliographic entry see Field 5G. W91-10152

### PERFORMANCE EVALUATION OF EARTH-

Trautwein Soil Testing Equipment Co., P.O. Box 31429, Houston, TX 77231.

S. J. Trautwein, and C. E. Williams.
IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 30-51. 3 fig, 16 ref.

Descriptors: \*Clay liners, \*Geosynthetics, \*Geotextiles, \*Landfills, \*Liners, Hydraulic conductivitextness, "Landmiss, "Liness, riviginatine conductivity, In situ tests, Infiltrometers, Laboratory methods, Leachates, Monitoring, Performance evaluation, Testing methods, Waste disposal.

Past and current methods of evaluating the per-formance of earthen liners are reviewed. Laborato-ry testing of small diameter samples in the design phase was the primary means of performance eval-uation in the past. Current performance evaluation involves testing in the design, construction, and service phases of a liner project. Emphasis today is service phases of a liner project. Emphasis today is on large scale on-site testing to account for the impact of secondary features on hydraulic conductivity. Several case histories are presented in which the liner contained obvious secondary features (macropores). In situ hydraulic conductivity measured using a sealed double ring infiltrometer was between three and one hundred times that measurements. ured in the laboratory using small diameter samples. Compressive stresses, smearing over macro pores, and reduction in the size of macro pores due to confining pressure in the laboratory could all contribute to lower hydraulic conductivity values measured in the laboratory compared to the field. measured in the laboratory compared to the field. Laboratory hydraulic conductivity tests on large diameter samples (300 mm) are recommended during the construction period to overcome these problems. (See also W91-10150) (Geiger-PTT) W91-10153

### FIELD BEHAVIOR OF DOUBLE-LINER SYS-

GeoSyntec Consultants, Norcross, GA.

R. Bonaparte, and B. A. Gross.

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 52-83. 3 fig, 11 tab,

Descriptors: \*Infiltration, \*Landfills, \*Leakage, \*Liners, \*Performance evaluation, \*Waste disposal, \*Water pollution prevention, Clay liners, Field tests, Geotextiles, Hazardous waste disposal, Waste management.

Field data is presented on flows of liquid from the leakage detection layers of double-liner systems at 30 landfill and surface impoundment facilities. Po-tential sources of leakage include leaching through the top liner, precipitation that percolates into the leakage detection layer during construction, groundwater infiltration, and consolidation of any clay component of the top liner. The flow rates attributable to top liner leakage at active cells that and decomembrane top liners and construction qual-ity assurance (CQA) programs were frequently less than 200 liters per hectare of lined area per day (lphd); the maximum measured flow rates, which were often associated with increased flow from the were often associated with increased now from the leachate collection layers shortly after storm events, were typically several times the average flow rates. Very little leakage detection layer flow was observed at double-lined surface impoundment was observed a double-inter surface impoundment ponds constructed with geomembrane top liners. The low flows may be attributed to the use of ponding tests and/or leak location surveys to iden-tify geomembrane defects and allow their repair. The use of ponding tests and/or leak location surveys reduces the frequency and/or size of geomembrane holes below those assumed by previous researchers. The double-lined landfills and surface impoundments in this study having a layer of com-pacted clay as the soil component of a composite top liner almost always exhibited flows due to consolidation water in the range of 20 to 840 lphd. Only very small flows were observed from the leakage detection layers of cells where the soil component of the composite top liner was a pre-fabricated geotextile-bentonite mat. An action leak-age rate of 200 lphd is recommended for landfills that have been constructed using rigorous third-party CQA programs. (See also W91-10150) (Geiger-PTT) W91-10154

#### FACTORS CONTROLLING THE LONG-TERM PROPERTIES OF CLAY LINERS.

California Univ., Berkeley. Dept. of Civil Engi-

J. K. Mitchell, and M. Jaber

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 84-105. 6 fig, 31 ref.

Descriptors: \*Clay liners, \*Landfills, \*Liners, \*Waste disposal, Design criteria, Hydraulic conductivity, Leakage, Performance evaluation, Soil

The properties of clay liners and their susceptibility to changes with time are major concerns in design for waste repositories. The desired proper-ties of clay liners include: low hydraulic conducties of clay liners include: low hydraulic conductivity, low diffusivity, ductility, stability on slopes, adequate interface strength, long-term stability, chemical retardation, high effective porosity, and constructibility. The factors affecting the long-term stability of clay liners are: (1) soil composition, including gradation, plasticity index, and type of mineral; (2) placement conditions and construction effects, including moisture content and density, compaction method and effort, size of clods, bonding between lifts, excessive wetting desiccabonding between lifts, excessive wetting, desiccabonding between mis, excessive wetting, desicta-tion, and frost conditions; (3) post-construction changes, including change in confining stress, clog-ging due to fine particle migration or biological activity, piping, differential settlements below the liner, the effects of freezing, and slope instability; and (4) chemical compatibility between the clay

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Ultimate Disposal Of Wastes-Group 5E

liner and the contained waste. (See also W91-10150) (Geiger-PTT) W91-10155

LONG-TERM DURABILITY AND AGING OF GEOMEMBRANES.

Drexel Univ., Philadelphia, PA. Geosynthetic Research Inst.

search inst.
R. M. Koerner, Y. H. Halse, and A. E. Lord.
IN: Waste Containment Systems: Construction,
Regulation and Performance. Geotechnical Special
Publication No. 26. American Society of Civil
Engineers, New York. 1990. p 106-134. 6 fig, 3 tab,

Descriptors: \*Degradation, \*Geosynthetics, \*Landfills, \*Liners, \*Materials testing, \*Waste disposal, Leachates, Performance evaluation, Polymers, Stress analysis.

Despite the large data base on polymer degradation, the life expectancy of geomembranes is still largely unknown. Geomembranes are essentially impermeable membranes used with foundation (soil, rock, earth or any other geotechnical engineering related material) as an integral part of a man-made project, structure or system. Several types of geomembranes are commonly used: stiff (semi-crystalline) thermoplastic geomembranes; and reinforced, flexible (low crystallinity) thermoplastic geomembranes, and reinforced, flexible (low crystallinity) thermoplastic geomembranes, include: ultraviolet degradation of geomembranes include: ultraviolet degradation, degradation by swelling, degradation, degradation, degradation, degradation, degradation, obligation, degradation, degradation, obligation, degradation by delamination, oxidation of the geomembrane greatly diminishes and even eliminates many of the degradation processes to which geomembranes are subject. Certain synergistic effects can accelerate the degradation processes, including elevated temperatures, applied stresses, and long exposure to any of the various degrading elements. The rate process method for testing geomembranes uses a notched constant load test on samples of the geomembrane sheet. Arrhenius modeling in a specially designed chamber can be used to test the tensile strength and elongation, yield strength and elongation, and stress cracking behavior of geomembranes. Some stress tests for pipes can also be adapted for qualitative stress testing of geomembranes. (See also W91-10150) (Geiger-PTTT)

# CONSTRUCTION AND PERFORMANCE OF A LONG-TERM EARTHEN LINER EXPERIMENT.

MEN1.
Illinois State Geological Survey Div., Champaign.
K. Cartwright, and I. G. Krapac.
IN: Waste Containment Systems: Construction,

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 135-155. 5 fig, 3 tab, 46 ref.

Descriptors: \*Clay liners, \*Hydraulic conductivity, \*Landfills, \*Liners, \*Performance evaluation, \*Waste disposal, Design criteria, Infiltration, Monitoring, Simulation analysis, Water pollution prevention.

In land burial schemes, compacted soil barriers with low hydraulic conductivity are commonly used in cover and liner systems to control the movement of liquids and prevent groundwater contamination. An experimental liner measuring 8 by 15 by 0.9 m was constructed with design criteria and equipment to simulate construction of soil liners built at waste disposal facilities. The surface of the liner was flooded with a 29.5 cm deep pond on April 12, 1988. Infiltration of water into the liner was monitored for two years using 4 largering (1.5 m OD) and 32 small-ring (0.28 m OD) infiltraters, and a water-balance that accounts for total infiltration and evaporation. Average long-term infiltration fluxes based on two years of monitoring are .58 picometers/sec, 60 nanometers/sec and 56 nanometers/sec for the largering, small-ring, and water-balance data, respectively. The saturated hydraulic conductivity of the liner

based on small-ring data, estimated using Darcy's Law and the Green-Ampt Approximation are 30 nanometers/sec and 40 nanometers/sec, respectively. All sets of data indicate that the liner's performance exceeds that which is required by the U.S. EPA. (See also W91-10150) (Author's abstract) W91-10157

### DETAILED CASE HISTORY OF CLAY LINER PERFORMANCE.

Golder Associates, Mississauga (Ontario).
D. W. Reades, L. R. Lahti, R. M. Quigley, and A.

D. W. Keades, L. R. Lanti, R. M. Quigley, and A. Bacopoulos.
IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 156-174. 9 fig, 3 tab, 5 ref.

Descriptors: \*Clay liners, \*Landfills, \*Liners, \*Monitoring, \*Ontario, \*Water pollution prevention, Case studies, Chlorides, Diffusion, Hydraulic conductivity, Infiltration, Leachates, Leakage, Onsite tests, Performance evaluation.

The Keele Valley Landfill at Maple, Ontario, consists of a 99 ha (245 acres) facility designed to serve the Metropolitan Toronto area. The landfill is located in a former sand and gravel pit, with the base and sides of the pit lined with at least 1.2 m of low plasticity clay till compacted to achieve the required hydraulic conductivity equivalent to 10 nanometers/sec or less. A comprehensive monitoring program on the in situ performance of the clay till liner was initiated in 1983. Results of monitoring to date indicate that the liner is performing as required and good agreement between the results of laboratory hydraulic conductivity tests and the in-situ liner performance monitoring program have been obtained. Based on results to date, the rate of contaminant migration into the liner is governed by diffusion. There have been no indications from the sub-liner samplers that salts in the leachates from the Keele Valley site have reached the underlying aquifer. Leachate heads above the liner are less than 3 m. Hydraulic conductivity for the shallow lysimeters fell within a range from 17 to 31 picometers/sec with an average of 95 picometers of chloride in the shallow lysimeters have increased gradually with time but are still less than 100 mg/L even in those installed in 1983. Four of the conductivity sets show salt concentration increases down to a maximum depth of about 0.75 m after five years; the fifth was showing a more rapid advance but this slowed during 1989. (See also W91-10150) (Geiger-PTT)

# SUMMARY REVIEW OF CONSTRUCTION QUALITY CONTROL FOR COMPACTED SOIL LINERS.

Texas Univ. at Austin. Dept. of Civil Engineering. D. E. Daniel.

D. E. Daniel.

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 175-189. 2 fig, 3 tab,

Descriptors: \*Design criteria, \*Landfills, \*Liners, \*Materials testing, \*Performance evaluation, \*Quality control, \*Waste disposal, Hydraulic conductivity, Permeability, Soil compaction.

Construction quality control testing is crucial to the successful performance of compacted soil liners and covers. Construction quality control is designed to verify that (1) materials used in construction are adequate; (2) the methods of construction are acceptable; and (3) liners and covers are adequately protected during and after construction. The most important factors in achieving low hydraulic conductivity in compacted soil liners are: using suitable materials, placing the soil at the correct water content, properly preparing the surface to receive a lift of soil, compacting the soil with adequate passes from the proper type of compactor, and protecting each compacted lift from damage. To verify that the materials and methods

of construction will produce the desired results, construction of a test pad is recommended. Several ASTM methods are recommended for materials testing including percent fines, percent gravel, liquid and plastic limits, and water content. Construction oversight observations should be made continuously in the borrow pit on major projects and continuously in placement areas on smaller projects. These recommended tests and their frequency of performance are offered as guidelines for certain projects and not as quantitative or absolute values that apply to all projects. (See also W91-10150) (Geiger-PTT)

### GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE.

GeoServices, Inc., Boynton Beach, FL. J. P. Giroud, and I. D. Peggs.

Dr. Corroud, and I. D. Feggs.

In: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 190-225. 5 fig, 2 tab, 27 ref

Descriptors: \*Geosynthetics, \*Geotextiles, \*Landfills, \*Liners, \*Materials testing, \*Performance evaluation, \*Waste disposal, Design criteria, Materials engineering, Membranes, Polymers, Shear tests, Stress analysis, Temperature effects, Thermal expansion.

Geomembrane construction quality assurance requires knowledge of the behavior of geomembranes from testing and from forensic analyses of lining systems that have failed. The goals of quality assurance are to verify and document that the geomembrane delivered to the site meets the specifications, is installed according to design and installation specifications, and that the materials adjacent to the geomembrane are placed according to specifications to minimizing damage to the geomembrane. A construction quality assurance plan developed in conjunction with the project specifications is typically a site-specific document. A final report specifying any deviations from the original design plan and all construction records is made after final construction. Seam tests are performed both nondestructively in the field and destructively in the laboratory. The cost of quality assurance varies from 5 to 20% of the cost of the geomembrane (material plus installation). Extensive construction quality assurance programs decreased the number of defects by a factor of 30 compared to installation without quality assurance. Temperature effects on geomembranes can be either reversible or irreversible. Two reversible effects are the change in geomembrane modulus with temperature and thermal expansion-contraction. An irreversible shrinkage is due to loss of volatile components and elief of internal stresses. Shrinkage due to loss of volatile components is insignificant in the case of high density polyethylene but may be between 0.5% and 2% for polyvinyl chloride. Shrinkage may be impeded by soil-geomembrane in a trench or to appurtenant structures. Thermal expansion-contraction varies with membrane material and soil upon which the geomembrane rests. Friction at the soil-geomembrane inferface will cause wrinkling of the geomembrane. Recommendations are made for time of placement and proper slack to be used when installing geomembrane. (See also W91-10150) (Geiger-PTT)

#### FIELD VERIFICATION OF CLAY LINER HY-DRAULIC CONDUCTIVITY.

Browning-Ferris Industries, Houston, TX. G. W. Johnson, W. S. Crumley, and G. P. Boutwell.

In: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 226-245. 4 fig, 5 tab, 17 ref.

### Group 5E-Ultimate Disposal Of Wastes

Descriptors: \*Clay liners, \*Hydraulic conductivi-ty, \*Landfills, \*Performance evaluation, \*Testing methods, \*Waste disposal, Comparison studies, Field tests, Infiltration, Permeability, Regression analysis, Soil compaction, Soil density

Test data from actual clay liner construction were analyzed to determine the correlation between nanyaccu to determine the correlation between field and laboratory measured values of hydraulic conductivity. A multi-variate regression analysis was also performed on data from four previously constructed clay liners to develop an equation to predict hydraulic conductivity as a function of the liquid limit, saturation, and density of the compacted clay. Two prototype clay liners were built using construction procedures similar to those used in cell liner construction. Pan lysimeters, sealed double-ring infiltrometers, and Boutwell permeameters were used to measure field conductivity values. Flexible wall and fixed-ring laboratory tests were used to measure laboratory conductivity values. Ratios of field to laboratory measured values ranged from 0.6 to 2.0. All field measured values were within a factor of 3.3 of the values predicted by the regression equation developed for this site. (See also W91-10150) (Author's abstract) W91-10161

### ATTENUATING MATERIALS IN COMPOSITE

Bucknell Univ., Lewisburg, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-10162

### TWO-PRONGED APPROACH TO SLUDGE

COMPOSTING.
J. F. Donovan, B. W. Sever, and L. Thibodeaux.
Biocycle BCYCDK, Vol. 32, No. 4, p 56-59, April
1991. 2 fig, 2 tab, 1 ref.

Descriptors: \*Compost marketing, \*Composting, \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater facilities, Odor control.

The city of Oceanside, California, is constructing an in-vessel composting facility to handle sludge from its two wastewater treatment facilities. The first stage of composting (which includes pathogen destruction and moisture reduction) will be accomplished using eight Ashbrook-Simon-Hartley (ASH) tunnel reactors. The reactors are sized to (ASH) tunnel reactors. The reactors are sized to provide a 14 day volumetric detention time (the time needed for material to pass through the reactor once). The aerated static pile method (enclosed in a building) was selected for the curing phase. The solids retention time (SRT) of this phase will be 21 days. This option can meet the city's goal of low profile buildings and good odor control. Overall, the total SRT of the system would be 47 days in the design year. Odor control will be accomplished by a 5-part plan: (1) minimizing generation of odorous compounds through design and operations, including monitoring of reactor temperations, including monitoring of reactor temperaations, including monitoring of reactor tempera-tures to ensure proper airflow rates and aerobic conditions; (2) odor containment through enclo-sure of all facilities; (3) routing and control of ventilation rates to minimize the quantity of air requiring treatment; (4) treatment of odorous air by a series of control systems designed to remove a broad spectrum of odor components; (5) design of stack systems that take advantage of atmospheric stack systems that take advantage of atmospheric dispersion. The major compost users marketed will include public agencies involved in horticultural activities and land reclamation, soil brokers, pri-vate non-agricultural users such as landscapers, vate non-agricultural users such as landscapers, nurseries, tree farms, golf courses, etc., agricultural users, and the general public. The marketing plan will have the city pursue long-term contracts with one or more brokers rather than do the marketing itself. This minimizes the city's risk related to compost marketing, which is consistent with the city's integrated in organical reality integration and proposed the contract in organical reality integration. city's interest in creating a reliable sludge disposal system. (Sand-PTT) W91-10218

#### SEPTAGE DEWATERING, TREATMENT AND COMPOSTING.

E and A Environmental Consultants, Inc., Cary,

T. Williams, M. Gould, and T. Callihan. Biocycle BCYCDK, Vol. 32, No. 4, p 66-75, April 1991. 5 fig, 8 tab, 7 ref.

Descriptors: \*Composting, \*Rural areas, \*Septic sludge, \*Sludge drying, \*Sludge treatment, \*Sludge utilization, \*Wastewater facilities, Cost

The septage, dewatering, and composting facility of the rural town of Thompson, New York is located at the town's existing Kiamesha Lake wastewater treatment plant, an advanced secondary facility with one MGD capacity. Sludge treatment currently includes dewatering in a lagoon and landfilling. The facility pretreats the septage by removing much of the suspended solids and BOD. The septage is conditioned with polyelectrolyte and mechanically dewatered on a screw press, separating most of the suspended solids and BOD from the liquid. The liquid filtrate is aerated to reduce the BOD further and is then treated along with raw wastewater (sewage). The dewatered with raw wastewater (sewage). The dewatered septage is then mixed with wood shavings and septage is then limited with wood shavings and composted by the forced air static pile process. Operation of the facility has proven to be very successful. The dewatering of domestic septage with low levels of grease utilizing the Somat with low levels of grease utilizing the Somat Screw Press appears to be an appropriate technology for small scale facilities. The dewatering equipment produced a dry sludge cake in excess of 20% solids and provided a suspended solids capture rate between 85-90%. The static pile method of composting produced a temperature level necessary to meet state and PFRP requirements. The finished compost met state guidelines in all but a few sampling events where slightly elevated copper levels were noted, apparently a result of leaching of copper from copper pipes in water supply lines. The economics of the system are very favorable. If such a facility were operated using yard wastes as a bulking agent or wood chips recovered through a bulking agent or wood chips recovered through screening, and if compost were sold to users, the screening, and if compost were sold to users, the cost of treating septage would be reduced significantly from the current \$55 per 1000 gallons. The successful operation of this facility demonstrates the viability of such a system for rural communities. The basic facility can be easily adapted to make the most efficient use of existing equipment and facilities. (Sand-PTT) W91-10219

# MORPHOLOGY AND MICROCHEMISTRY OF SOLIDIFIED/STABILIZED HAZARDOUS WASTE SYSTEMS.

Louisiana State Univ., Baton Rouge. Dept. of

F. K. Cartledge, H. C. Eaton, and M. Tittlebaum. F. K. Cartledge, H. C. Eaton, and M. Tittlebaum. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134156. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/2-89/056, November 1989. 90p, 30 fig, 27 tab, 43 ref. EPA Cooperative Agreement No. CR-812318-01-0.

Descriptors: \*Cements, \*Hazardous waste disposal, \*Phenols, \*Waste containment, \*Waste disposal, Chemical analysis, Chemical properties, Ethylene glycol, Leaching, Materials testing, Organic compounds, Organic wastes, Performance evaluation, Solubility, Water pollution control.

Studies of water soluble organics, including ethylene glycol and phenols, in Type I Portland cement have been carried out using leaching tests, physical tests, and a variety of microscopic and spectroscopic techniques. The systems studied are now the most thoroughly characterized combinations of organics with cement pastes. None of the water soluble organics are effectively immobilized, even though the phenols are converted to calcium salts, which are less soluble in water than the original phenol. The organics are responsible for substantial changes in the cement matrix itself. These changes changes in the cement matrix itself. These changes have been identified, and further work will attempt to correlate the changes with increased or de-creased effectiveness of immobilization. A somewhat surprising result is the relatively small changes in compressive strength which results from the inclusion of large amounts of phenols. The strength is maintained even though there are major changes in the morphologies of the cement

phases and even the chemical nature of the phases. The presence of ethylene glycol, on the other hand, gives rise to a steadily decreasing compressive strength as additional glycol is added. Another surprising observation is the qualitative difference in the distribution pattern of p-bromophenol in the cement matrix compared to p-chlorophenol. The result demonstrates that the new years salt to harder cement matrix compared to p-chlorophenol. The result demonstrates that even very subtle changes in chemical composition of the waste can result in major changes in immobilization mechanism and efficiency. (Author's abstract) W91-10233

# INCINERATION OF CREOSOTE AND PEN-TACHLOROPHENOL WOOD-PRESERVING WASTEWATER TREATMENT SLUDGES,

PEI Associates, Inc., Cincinnati, OH. F. D. Hall.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-130493. Price codes: A07 in paper copy, A01 in microfiche, Report No. EPA/600/2-89/060, November 1989. 120p, 4 fig, 70 tab, 19 ref. EPA Contract 68-03-3389.

Descriptors: \*Creosote, \*Incineration, \*Pentachlorophenol, \*Sludge treatment, \*Toxic wastes, \*Wastewater treatment, Arsenic, Barium, Copper, Heavy metals, Lead, Performance evaluation, Selenium, Thallium, Vanadium, Wood preservatives,

The bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use pentachlorophenol (PCP0 or creosote) is called K001 waste. Incineration and fuel substitution were the treatment technologies identified as being applicable to best demonstrated available technology (BDAT)-list organic constituents in K001. Incineration destroys the organic constituents in wastes. Like incineration, fuel substitution destroys wastes. Like incineration, ruei substitution destroys the organic constituents of a waste while deriving a fuel value from the waste. Nine data sets (untreated and treated waste) were collected during test burns to characterize the treatment performance of rotary kiln incineration on K001. Three of ance of rotary kin incineration on Kool. Three of these data sets represent K001 wastes from wood preserving processes using PCP-based preservative chemicals, and six are from K001 wastes contain-ing creosote. Both K001 wastes proved to be incining creosote. Both KOOI wastes proved to be incinerable; the waste streams generated by both were ash and scrubber water effluent. In KOOI-PCP wastes, no BDAT volatiles or semivolatiles were detected above the practical quantitation limits (PQL) in the KOOI-PCP ash, ash TCLP, and scrubber water samples. The BDAT-list metals found in the ash that were above the PQL were As, Ba, Cr, Cu, Pb, and Zn. Only Pb and Zn were detected above the PQL in the TCLP extracts of the ash. As, Ba, Cu, Pb, and Zn were detected above the PQL in the scrubber water samples. In KOOI-creosote wastes, with one exception, no BDAT-list volatiles or semivolatiles were detected in the KOOI-C ash, ash TCLP, or scrubber water in the K001-C ash, ash TCLP, or scrubber water samples above the PQL. Ba, Cu, Pb, and Zn were the major BDAT-list metals found in the feed samples. The ash contained As, Ba, Cr, Cu, Se, Va, and Zn above the PQL, but the TCLP extracts contained only Ba and Zn above the PQL. Pb, Th, and Zn were the major metals present in the scrub-ber water samples. No BDAT-list organophosphorus pesticides, organochlorine pesticides, poly-chlorinated biphenyls, organochlorine herbicides, dioxins, or furans were detected above the PQL in any of the K001-C samples. (Lantz-PTT) W91-10234

## PRELIMINARY DATA SUMMARY DRUM RECONDITIONING INDUSTRY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126491. Price codes: A07 in paper copy, A01 in microfiche. Report No. EPA/550/1-89/101, September 1989. 116p, 5 fig. 49 tab, 15 ref. EPA Contract Nos. 68-03-3509, 58-03-3366, and 68-03-3339.

Descriptors: \*Drum, \*Waste disposal, \*Wastewater treatment, Costs, Dioxins, Furans,

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Ultimate Disposal Of Wastes—Group 5E

Herbicides, Organic compounds, Pesticides, Sludge treatment, Volatile organic compounds, Waste storage, Wastewater treatment facilities.

Steel and polyethylene drums are reconditioned for reuse at 450 facilities located throughout the United States. The average drum reconditioner handles 427 drums daily and discharges 6.9 gal of wastewater/reconditioned drum, or 3,000 gpd (gal/day). Raw wastewater results from the washing and rinsing of tight-head drums or the quenching of burning residue on open-head drum surfaces. Tight-head facilities generally discharge wastewater, and nearly one-half of the dischargers do not treat wastewater. A model wastewater treatment system would include emulsion breaking treatment system would include emulsion breaking technology and treated wastewater reuse. A typical facility would incur a capital cost of \$154,000 and an annual operating cost of \$47,000 to maintain and operate such a system. Approximately 124 million pounds of residue are contained in drums received by reconditioners, annually. Wastewater treatment sludges generated by the industry are composed mainly of oil and grease (15%) and suspended solids (7%). Twelve dioxin/furan compounds were found in industry sludges; however, these compounds are not prevalent in raw wastewaters. The annualized wastewater control cost is \$.078/drum reconditioned, which represents about 12% of the reconditioning fee. (Lantz-PTT) W91-10241 W91-10241

## PRELIMINARY DATA SUMMARY FOR THE HAZARDGUS WASTE TREATMENT INDUS-

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5D. W91-10242

LONG-TERM EFFECTS OF SEWAGE SLUDGE AND FARM SLURRIES APPLICATIONS. Proceedings of a Round-Table Seminar organized by the Commission of the European Communities, Directorate-General Science, Research and Devel-opment, Environment Research Program, Pisa, Italy, September 25-27, 1984. Elsevier Applied Sci-ence Publishers, London. 1985. Edited by J. H. Williams, G. Guidi, and P. l'Hermite.

Descriptors: \*Land disposal, \*Sludge disposal, \*Sludge utilization, \*Wastewater farming, \*Water pollution effects, Agriculture, Conferences, Nitrogen, Nutrients, Phosphates, Phosphorus, Potassium, Seminars, Waste disposal.

This book contains the proceedings of a semina This book contains the proceedings of a seminar devoted to the residual and longer-term benefits of sewage sludges and farm slurries, and was the first seminar which brought together experts from both the sewage sludge and animal manure sides to discuss their common problems. Although liquid sludges and animal slurries have much in common, the main components of both products being nitrogen and organic matter, they have differences which must be considered. On grass/arable farms, the benefits from sewage sludge can be complethe benefits from sewage sludge can be comple-mentary to those of animal slurries in terms of mentary to those of animal slurries in terms of providing an organic manure with an improved balance of nitrogen, phosphorus and potassium for grass and arable crops. There are papers which deal with: the availability of soil nutrients from sludges and slurries treated in different ways; on the phosphate balance in soil; and the soil ameliorating properties of these organic amendments. Changes on storage and mineralization in soils after treatment with sludges stabilized by different methods are also discussed, along with the important aspect of evaluating the composition of sludges and slurries. Variability in slurry composition often makes it desirable to obtain an 'on the farm' estimate of nutrient value if they are to be farm' estimate of nutrient value if they are to be used efficiently without detriment to the environment. (See W91-10271 thru W91-10290) (Lantz-PTT) W91-10270

#### USE OF DIGESTED EFFLUENTS IN AGRI-CULTURE.

Universite Catholique de Louvain, Louvain-la-

Neuve (Belgium). For primary bibliographic entry see Field 3C. W91-10271

### SOIL MICROORGANISMS AND LONG-TERM FERTILITY. Istituto di Radiobiochimica ed Ecofisiologia Vege-

Istituto di Radiobiochimica ed Econsologia Vege-tale, Rome (Italy). U. Tomati, A. Grappelli, and E. Galli. U. Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Sci-ence Publishers, London. 1985. p 14-21, 5 fig, 14

Descriptors: \*Fertilizers, \*Land disposal, \*Micro-organisms, \*Sludge disposal, \*Soil organisms, \*Waste disposal, Aerobic digestion, Agriculture, Anaerobic digestion, Biological studies, Corn, Crops, Nitrates, Nitrogen, Nutrients, Oxygen, Phosphorus.

Sludge supplies many plant nutrients to soil, especially N and P, and organic matter, which stimulates microbial activities upon which soil biological cycles depend. The biological cycles are responsi-ble for the mineralization and biosynthesis of many ble for the mineralization and biosynthesis of many active metabolites. Experiments were conducted over a 4-yr period on corn crops, during which time heavy doses of both aerobic and anaerobic sludge were applied. Microbial population, oxygen consumption, auxin production, and total nitrogen and nitrate content were followed every year at the time of emergence. Crop production as q/ha and protein/ha was also assayed every year. Sludge supply stimulated soil oxygen consumption, which was considered to be an index of increased microbial population and its activities. As a consewhich was considered to be an index of increased microbial population and its activities. As a consequence of more efficient mineralization, a high content of available ions, in particular N-NO3(-), was recorded. Phytohormone production by soil microorganisms was strongly stimulated. Cropyield and quality improved, especially after aerobic treatment. (See also W91-10270) (Author's abstract)

# COMPARISON OF THE EFFICIENCY OF NI-TROGEN IN THE CATTLE AND PIG SLUR-RIES PREPARED ACCORDING TO THREE METHODS: STORAGE, AERATION AND AN-AEROBIC DIGESTION.

Eidgenossische Forschungsanstalt für Agricultur-chemie und Umwelthygiene, 3097-Liebefeld-Bern,

chemie und University and P. Lischer.

J. M. Besson, R. Daniel, and P. Lischer.

IN: Long-Term Effects of Sewage Sludge and
Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 22-32, 2 fig, 5 tab, 13 ref.

Descriptors: \*Aeration, \*Animal wastes, \*Nitro-gen, \*Slurries, \*Waste disposal, \*Wastewater farm-ing, \*Wastewater treatment, Agriculture, Anaero-bic digestion, Farm wastes, Land disposal, Nutri-

Aerated cattle and pig slurries have very low mineral nitrogen contents, and high organic nitrogen contents. Stocked slurries are in an intermediary position between aerated cattle and pig slurries, and anaerobic digested slurries which have the highest mineral nitrogen content. Nitrogen efficiency in the slurries, as demonstrated by pot trials with Italian rye grass harvested three times annually, was lower for aerated slurries than the others, not only for the first harvest (direct effect) but also not only for the first harvest (direct effect) but also for subsequent harvests (after effect). Organic nitor subsequent narvess quarie enecty. Organic introgen in acrated slurries undergoes the same fate as that of the other slurries; soil organic nitrogen usually rises 1-3% annually, and is only slightly available to plants. Depending on the method of avanatic to piants. Depending on the method of slurry preparation, the relationship between the fraction of ammonia nitrogen in the slurries and the observed parameters on the rye grass, was not obvious. (See also W91-10270) (Author's abstract) W91-10273

LONG-TERM EFFECTS OF THE LANDS-PREADING OF PIG AND CATTLE SLURRIES ON THE ACCUMULATION AND AVAILABIL-ITY OF SOIL NUTRIENTS.

Istituto Sperimentale per lo Studio e la Difesa del Suolo, Florence (Italy). P. Spallacci, and V. Boschi.

In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 33-44, 3 fg, 3

Descriptors: \*Animal wastes, \*Land disposal, \*Nu-trients, \*Slurries, \*Waste disposal, Crop yield, Farm wastes, Fertilizers, Lysimeters, Organic carbon, Phosphorus, Potassium.

Long-term experiments were conducted in plots and with lysimeters using pig and cattle slurry applications repeated for several years (from 3-5 yrs) on different soil types. The soil contents of total N, organic C, available P and exchangeable K were measured at various times: (1) beginning of the trials; (2) end of the slurry treatment period; and (3) end of the period of residual effects. High period pe and () end of the period or residual effects. Figh enrichments of nutrients were found at the end of each slurry application period, and optimum crop yields were obtained during this time. In a subse-quent period of residual effects, in order to obtain high yields, additional N fertilizer applications were necessary. However, available P and exchangeable P contents were sufficient for crop requirements for an additional 2-3 years. Following this period, the P for pig slurry and K for cattle slurry were still at high levels of enrichment. (See also W91-10270) (Author's abstract) W91-10274

# RELATIONSHIPS BETWEEN SOIL STRUC-TURE AND TIME OF LANDSPREADING OF PIG SLURRY.

Institute for Soil Chemistry, C.N.R., Via Corridoni 78, 56100 Pisa (Italy).

M. Pagliai, M. La Marca, and G. Lucamante. In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 45-46, 4 fig, 2

Descriptors: \*Animal wastes, \*Land disposal, \*Soil amendments, \*Soil porosity, \*Waste disposal, \*Wastewater farming, Pore size, Porosity, Seasonal variation, Soil properties, Soil structure.

A field test was established in 1980 on a silty clay A neid test was established in 1980 on a silty clay soil to study various aspects of soil porosity as it relates to soil structure following the land spread-ing of pig slurry at three different times (February, June and October) each year. Porosity measure-ments were carried out on large thin sections of ments were carried out on large thin sections of undisturbed soil samples by means of electro-optical image analysis (Quantimet 720). The land spreading of pig slurry significantly increased the total porosity and modified the size distribution, the shape, and the arrangement, of the pores. These modifications were the result of an increase of soil aggregates following the addition rate of the slurry, but it was different according to the different times of land spreading. At the beginning of the experiment, the June application was the most efficacious, while the application in October did not show any difference with respect to the control. In the final year, the June application still showed gave the best results, but the October application also showed a significant improvement with respect to the control. The effect of the February application was intermediate between the February application was intermediate between the other two. (See also W91-10270) (Author's abstract) W91-10275

# RESULTS OF LARGE-SCALE FIELD EXPERIMENTS WITH SEWAGE SLUDGE AS AN ORGANIC FERTILIZER FOR ARABLE SOILS IN IFFERENT REGIONS OF THE NETHER-

Institute for Soil Fertility, Haren (Netherlands). S De Haan

IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 57-72, 7 fig. 12

### Group 5E-Ultimate Disposal Of Wastes

Descriptors: \*Arable soils, \*Fertilizers, \*Organic compounds, \*Sludge disposal, Cereal crops, Minerals, Nitrogen, Potatoes, Soil chemistry, Sugar heaterstands.

In 1977, a series of six field experiments was begun in which sewage sludge was applied to arable soils in amounts of 0, 10 and 20 t DM/ha to root crops in amounts of 0, 10 and 20 t DM/ha to root crops (sugar beet and potatoes), normally grown every second year, but sometimes more frequently, alternating with cereals. In the years of sludge application, large plots (30 m x 30 m) were subdivided into five small plots receiving different rates of mineral fertilizer N. This made it possible to construct yield curves with which the nitrogen effect of the sludge could be measured, and maximum yields determined without and with sewage sludge. In 1982, the effect of sludge applications on soil characteristics was determined. Sludge was found to be a rather unpredictable source of nitrogen. The maximum yield of potatoes increased with The maximum yield of potatoes increased with sludge application in a number of cases, and there was a positive after-effect on the grain yield of cereals. The phosphorus effect of sludge was apparent, causing a considerable improvement in the phosphorus status of the soils. Following sludge application, concentrations of microelements increased in soils in general, but not to an alarming degree, and only insignificantly in crops. (See also W91-10270) (Author's abstract) W91-10276

### CUMULATIVE AND RESIDUAL EFFECTS OF SEWAGE SLUDGE NITROGEN ON CROP GROWTH

ater Research Centre, Medmenham (England). Medmenham Lab.

J. E. Hall. In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Sci-ence Publishers, London. 1985. p 73-83, 4 fig, 7

Descriptors: \*Land disposal, \*Nitrogen, \*Sludge disposal, Fertilizers, Grasses, Nitrogen compounds, Organic carbon, Seasonal variation, Waste dispos-

Sewage sludges contain nitrogen in readily avail-Sewage sludges contain nitrogen in readily available inorganic and slow release organic forms. Organically-bound nitrogen is mineralized slowly over an extended period of time, and its availability is governed by the degree of sludge stabilization and its C:N ratio, as well as soil and climatic factors. Results from a number of experiments are described involving single and repeated applications of different types of sludge to grasslands. Effects are apparent within and between years, and are attributable to the residual sludge organic N. Nitrogen is released from a single sludge application in a predictable long-term manner with preis rejected from a single studge apprica-tion in a predictable long-term manner with pre-dictable accumulated residual effects following regular applications. Repeated applications of sludge increase the pool of mineralizable N in the studge increase the pool of mineralizable N in the soil, producing a progressive increase in midseason and late-season grass yields relative to early growth. Long-term residual effects can be expected from a single application of dewatered sludge. Nitrogen release from both undigested and digested sludges is predictable, with fertilizer replacement values decreasing by about half each year. Regular annual applications of liquid sludge have a cumulative effect on residual N values. Experimental data closely fit a theoretical model which indital data closely fit a theoretical model which indi-cates that the largest increase in residual value may be expected by the third year of repeated applica-tions. Cropping, climatic and soil conditions affect crop response to sludge, particularly unstabilized sludges. A poor response one year is generally compensated for by a large response the following year. (See also W91-10270) (Lantz-PTT) W91-10277

### LONG-TERM EFFECTS OF FARM SLURRIES APPLICATIONS IN THE NETHERLANDS,

Institute for Soil Fertility, Haren (Netherlands). L. C. N. De La Lande Cremer. IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 84-90, 2 fig, 4

Descriptors: \*Farm wastes, \*Netherlands, \*Slurries, \*Wastewater disposal, Animal wastes, Crop yield, Groundwater pollution, Manure, Nema-

Animal effluents are very valuable resources for supplying crops with minerals and maintaining or improving soil fertility. The amounts to be applied however, should be restricted depending on factors such as fertility status of the soil, maximum yield, crop quality and environmental requirements. Shoring contribute to an increase increase. ments. Slurries contribute to an increase in soil fertility and productivity. They are subject to the same natural laws as other fertilizing agents. Like other organic fertilizer materials, slurries in combination with mineral fertilizer give an attractive increase in production which cannot always be obtained with fertilizer alone. As is the case with fertilizers, the use of animal manures, or a combi-nation of the two can improve, maintain or reduce nation of the two can improve, maintain or reduce crop quality; success depends on determining the correct amount of nutrients to be applied, taking into account the supply of other fertilizing agents (fertilizer, sewage sludge). Excess is harmful to quality, but can be avoided by choosing the proper rate of application. When manures are applied in amounts that exceed crop and soil requirement—a situation that is rapidly created when surpluses exist (dumping)—elements that are not utilized will accumulate in the soil. Enrichment of the soil leads accumulate in the soil. Enrichment of the soil leads to eutrophication of the groundwater. Cattle and pig slurries can reduce the development of parasit-ic nematodes, and root necrosis in silage maize te nematodes, and root necrosis in suage maize even more effectively than a nematocide. Excessive amounts of pig slurry cause a reduction in the number of worms in grassland. Cu(HNO3)-contents higher than 30-50 mg/kg dry soil can result in a diminished reproductive capacity in these ani-mals. (See also W91-10270) (Lantz-PTT) W91-10278

# LONG-TERM FIELD EXPERIMENTS ON THE FERTILIZER VALUE AND SOILS AMELIO-RATING PROPERTIES OF DEWATERED SLUDGES.

Maatalouden Tutkimuskeskus, Jokioinen (Finland) I. Koskela.

IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 98-1077, 6 fig, 2

Descriptors: \*Fertilizers, \*Land disposal, \*Sludge disposal, \*Sludge drying, Barley, Clays, Field tests, Finland, Grain crops, Nitrogen, Sandy soils, Organic matter, Soil types.

Field experiments were carried out from 1973 thru 1982 at the Agricultural Research Centre, Finland, where the highest amount of digested sewage sludge applied was 100 T dry matter/ha. In addition to sewage sludge, 50 or 100 kg N/ha in NPK-fertilizer was applied every spring. The purpose of the study was to use half of the normal nitrogen amount as mineral fertilizer, in order to found out the effect of the sludge in both plant and soil the effect of the sludge in both plant and soil materials. Sewage sludge increased most of the materials. Sewage sludge increased most of the barley yields grown in clay soil rich in organic matter (at 700 kg/ha). Sludge increased barley yields only a few hundred kg/ha grown in sandy soil during years three and four. Nitrogen concentrations in the grain were highly dependent upon sludge treatments. Soil organic matter increased in clay soil with the sludge treatment. Guidelines prefer small sludge applications per year; 40-50 T dry matter/ha should give the most economic result when dewatered sludges are used. (See also W91-10270) (Lantz-PTT) W91-10279

# FERTILIZING VALUE OF SLURRY APPLIED TO ARABLE CROPS AND ITS RESIDUAL EFFECTS IN A LONG-TERM EXPERIMENT.

Faculte des Sciences Agronomiques de l'Etat, Gembloux (Belgium).

J. P. Destain, Y. Raimond, and M. Darcheville. IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Sci-ence Publishers, London. 1985. p 108-123, 11 fig, 6 tab, 19 ref. EEC Contract 251. Descriptors: \*Animal wastes, \*Arable soils, \*Fer-tilizers, \*Slurries, \*Wastewater disposal, Belgium, Crop yield, Loam, Soil properties.

An agronomic evaluation of livestock effluents was An agronomic evaluation of n'essoex etnems was conducted at the Agricultural Research Centre of Gembloux, Belgium as part of a large-scale joint program. Numerous experimental fields were set up, one of which was conducted in 1974 in Gembloux (a loamy region) with the aim of measuring the long-term efficiency of slurry N applied to arable crops, and to look at the slurry as the only potential source of N. By taking advantage of an existing experimental layout, it was possible to evaluate the overall fertilizing value of slurry, and consider its action on the autrient content and consider its action on the nutrient content, and some physical characteristics of the soil. An in-crease in plant nutrients will lead to an adjustment of the fertilizer dressings, and consequently to important financial savings. It was found that the soil structure of the experimental plots seems to be improve with the slurry dressings investigated. (See also W91-10270) (Lantz-PTT)

### EXPERIMENTS ON THE FERTILISER VALUE OF ANIMAL WASTE SLURRIES.

Ministry of Agriculture, Wolverhampton (Eng-

K. A. Smith, R. J. Unwin, and J. H. Williams IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Sci-ence Publishers, London. 1985. p 124-135, 10 tab,

Descriptors: \*Animal wastes, \*Fertilizers, \*Slurries, \*Wastewater disposal, \*Wastewater farming, Agronomy, Grasses, Nitrogen, Phosphorus, Potas-

A review is presented of the fertilizer value of animal waste slurries according to experimental work in the United Kingdom; results of studies are compared with the results of other workers. Agrocommic experiments demonstrated variable growth responses, particularly of grass to nitrogen obtained from applied cattle slurry. Further, the results suggest that frequent doses of dilute slurry are more effective than single dressings of high dry matter material. Residual effects have generally been small other than following very high dressings of slurry. Attempts to explain the variability in terms of factors such as slurry analysis, soil type and climatic effects have met with little success. Further agronomic experiments of the type described seem unlikely to contribute much more to existing knowledge. Attempts at optimizing the financial return from slurries take full account of their nutrient content and often aim to use the materials mainly as sources of P and K. (See also W91-10270) (Author's abstract) c experiments demonstrated variable growth W91-10281

# LONG-TERM EFFECTS OF SEWAGE AND PIG SLURRY APPLICATIONS ON MICRO-BIO-LOGICAL AND CHEMICAL SOIL PROPER-TIES IN FIELD EXPERIMENTS.

Forschungsanstalt für Agrikulturchemie und Um-welthygiene, Schwarzenburgstr. 155, 3097-Liebe-feld (BE), Switzerland.

F. X. Stadelmann, and O. J. Furrer. IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Sci-ence Publishers, London. 1985. p 136-145, 4 fig. 3

Descriptors: \*Land disposal, \*Microbiological studies, \*Sludge disposal, \*Soil chemistry, \*Wastewater disposal, Arable soils, Cation exchange, Farm wastes, Fertilizers, Field tests, Grasslands, Hydrogen ion concentration, Loam, Nitrogen, Organic matter, Phosphorus, Sand, Soil organisms, Soil properties, Zinc.

Long-term applications of sewage sludge and pig slurry increased soil humus content, N-content, CEC, heterotrophic soil microorganisms and their activities more in a light soil than in a heavy soil. In a 7-yr field experiment on a sandy loam soil (parabrown soil) receiving 5 T of organic matter/

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Ultimate Disposal Of Wastes—Group 5E

ha annually in the form of sewage sludge, apprecia ha annually in the form of sewage sludge, appreciable increases in the humus content, N content, pN values, contents of aerobic bacteria, and biological activities were observed. These changes were clearly seen up to a soil depth of 1 meter. Applications of sewage sludge at annual rates of 4 and 15 T organic matter/ha in a 5-yr field experiment on a loamy soil used for grasslands and arable crops have induced measurable after-effects on soil fertility. In sewage sludge fertilized soils, 7 years after the last application of sludge, an appreciable increase in the humus extractable P and Zn content, and in microbiological activities was found when and in microbiological activities was found when compared with soils treated earlier with mineral fertilizer. The after-effects due to heavy pig slurry doses were less pronounced. (See also W91-10270) (Author's abstract) W91-10282

PHOSPHATE BALANCE IN LONG-TERM SEWAGE SLUDGE AND PIG SLURRY FER-

SEWAGE SLUDGE AND FIG SLURRY FER-TILIZED FIELD EXPERIMENT.
Forschungsanstalt für Agriculturchemie und Um-weithygiene, Schwarzenburgstr. 155, 3097-Liebe-feld (BE), Switzerland.

teld (BE), Switzerland.
O. J. Furrer, and S. K. Gupta.
IN: Long-Term Effects of Sewage Sludge and
Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 146-150, 3 tab.

Descriptors: \*Animal wastes, \*Fertilizers, \*Phosphates, \*Sludge disposal, \*Slurries, \*Soil chemistry, Field tests, Nutrients, Organic matter, Phosphates, \*Company of the company of the c phorus, Soil properties.

Sewage sludge and pig slurry are organic waste fertilizers which contain large quantities of phosphorus. Their heavy application can lead to Paccumulation in soils. In order to find out the long-term effects of heavy and graded doses of sewage sludge and pig slurry, field experiments using different soils and different cropping systems were initiated in 1976. The P-export through plant uptake depends upon soil, application rate, and crop. In plots receiving a heavy application of sewage sludge, about 90% of the totally added P is retained in a 0-20 cm surface layer, but a small part is also moved into deeper layers. Accumulated P in soils originated from pig slurry is more soluble soils originated from pig slurry is more soluble than that from sewage sludge. (See also W91-10270) (Author's abstract)

CHEMICAL CHARACTERIZATION OF SOIL ORGANIC MATTER IN A FIELD STUDY WITH SEWAGE SLUDGES AND COMPOSTS. Pisa Univ. (Italy). Inst. of Agricultural Chemistry. R. Levi-Minzi, R. Riffaldi, G. Guidi, and G.

Poggio.

IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 151-160, 8 fig, 2

Descriptors: \*Compost, \*Land disposal, \*Organic matter, \*Sludge disposal, \*Soil chemistry, \*Vastewater, Aerobic digestion, Agriculture, An-aerobic digestion, Corn, Field tests, Fulvic acids, Humic acids, Loam, Organic carbon, Sand, Soil

Some characteristics of soil organic matter were determined in a field study established in 1978 on a sandy loam soil planted with corn. Treatments included a control (C), aerobic (AS) and anaerobic sludge (ANS), compost of the organic fraction of urban refuse with aerobic (CAS) and anaerobic sludge (CANS), farmyard manure (FYM) and min-eral fertilizers (MF). All organic materials were eral fertilizers (MF). All organic materials were applied yearly at a rate equivalent to 50 T/ha of manure on an organic carbon basis. The decomposition of the organic matter added to such a light soil was fast and only AS was able to increase soil organic-C. AS also increased total and mineral soil-N. The composition of the humified fractions of soil organic matter, derived from the determinations of humic and fulvic acids and gel filtration, was practically the same for all organic amendments for which the content of fulvic acids was ments for which the content of fulvic acids was much higher than that of humic acids. Differences among treatments were found only for alcohol

soluble substances. (See also W91-10270) (Author's abstract) W91-10284

EFFECT OF STORAGE ON THE UTILIZA-TION OF SEWAGE SLUDGE. Norges Landbrukshoegskole, Aas. Dept. of Soil Fertilization and Management.

In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 168-176, 4 fig, 4

Descriptors: \*Sludge digestion, \*Sludge disposal, \*Sludge utilization, \*Wastewater disposal, Ash, Biodegradation, Carbon, Composting, Nitrogen,

During storage, different characteristics of sludge can change. Samples of stored sludge were taken for analysis at different times and from different depths. The percent of dry matter and ash were found to increase during storage, especially in the surface layer. Water loss brings about a certain heighter of the volume. Decomposition degreesed shrinkage of the volume. Decomposition decreased the C/N-ratio, however, the percent of total nitrogen was not much changed by storage. A certain loss of N was, however, registered, representing that portion of nitrogen which could be most easily utilized by the plants. Experiments showed that composting, more than storage, reduced the effect of sludge compared to fresh sludge. Storage of raw sludge for several months can prevent phytotoxic effects. (Author's abstract) W91-10285

MINERALIZATION OF ORGANIC MATTER IN SOIL TREATED WITH SEWAGE SLUDGE STABILIZED BY DIFFERENT METHODS.

STABILIZED BY DIFFERENT METHODS. Naples Univ. (Italy). Ist. di Microbiologia Agraria. S. Dumontet, E. Parente, and S. Coppola. IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 177-189, 4 fig. 10 to b. 10 cef. tab, 10 ref.

Descriptors: \*Land disposal, \*Mineralization, \*Organic matter, \*Sludge disposal, \*Sludge utilization, \*Soil amendments, Aerobic digestion, Composting,

Organic matter mineralization was investigated in soils treated with the same sludge and stabilized by different processes: liquid aerobic digestion; dewatering and composting in mixture with wood chips; and, dewatering and composting with inert bulking agents. Carbon and nitrogen mineralization was agents. Catton and introgen initiratation was monitored during incubation as well as during field experiments. In vitro, the process of organic carbon mineralization was fastest for liquid digest-ed sludge. Applications of this type of material to a ed sludge. Applications of this type of material to a soil with a poor organic matter content had shown a positive priming effect, causing the mineralization of an organic carbon amount greater than the applied one. Different mineralization kinetics were defined for the various sludges assayed, pointing out that the mineralization of organic carbon of sludges stabilized in the solid phase is strongly affected by the application rate. Sludge composted with wood chips also significantly increased the organic carbon content of the soil. Under these experimental conditions, the application of liquid sludge also promoted an intense organic nitrogen mineralization, especially with respect to application rate. This type of sludge makes the largest amounts of inorganic nitrogen available to the soil. Among treatments, the application of sludge com-Among treatments, the application of sludge com-posted in mixture with wood ships caused the most posted in mixture with wood ships caused the most significant increase of soil microbial biomass and hydrolytic activities in the field. In incubation studies, the highest values of biomass were obtained in samples treated with liquid sludge. (See also W91-10270) (Lantz-PTT) W91-10286

SLUDGE ORIGINS AND NITROGEN EFFI-CIENCY.
Faculte des Sciences Agronomiques de l'Etat,

Gembloux (Belgium)

L. Barideau, and R. Impens.

IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 190-199, 10 tab, 7

Descriptors: \*Grasses, \*Land disposal, \*Nitrogen, \*Sludge disposal, \*Sludge utilization, Crop yield, Germination, Plant growth, Productivity, Temper-

The effect of sludges, produced in three very different sewage plants, on the growth of ray-grass at two temperatures and four sludge application rates, was tested. The existence of toxic products in the sludges was tested before the trial by a germination test with cress seeds. One of the sludges strongly inhibited the germination of cress seeds, but this effect didn't affect the growth of the ray-grass during the trial. Dry matter production and nitro-gen exportation were measured. Dry matter production was multiplied by a factor ranging be-tween 1.05 and 2.50, and nitrogen exportation by a factor ranging between 1.1 and 2.70 as compared to the control. Temperature increased the production by 3% to 20% and nitrogen exportation by 9% to 33%. Nitrogen efficiency was computed and found to be independent of temperature but largely dependent upon the sludge origin. (See also W91-10270) (Author's abstract) W91-10287

EVALUATION OF TYPE AND CONTENTS OF HUMIC SUBSTANCES IN SLUDGES AND COMPOSTS.

Udine Univ. (Italy).

M. De Nobili, G. Cercignani, and L. Leita. IN: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 204-209, 3 fig, 1

Descriptors: \*Composting, \*Humic matter, \*Pollutant identification, \*Sludge analysis, \*Sludge stabilization, \*Sludge treatment, \*Sludge utilization, Anaerobic digestion, Compost, Humic acids, Or-ganic carbon, Toxicity, Waste treatment.

Humic substances content and quality were investi-gated in samples from sewage sludge and composting plants. By determining total organic carbon in Na4P2O7 extracts, and in fractions not adsorbed on Polyclar AT, the ratio of non-humic to humic substances was calculated. This ratio was considered to be an index of the stabilization and possible low toxicity of the material. The quality of humic substances from a number of different organic wastes was examined by isoelectric focusing (IEF) and compared to that of stabilized soil organic matter. Humic acids from fresh and mature farmyard manure and from work compost show great similarity with soil humic acids, while samples of anaerobically digested sewage sludge or immature compost were seen to have completely different patterns. Maturation of compost or permanence in thickening beds lessens the differences in IEF patrelative to stabilized materials. (See W91-10270) (Author's abstract) W91-10288

EVALUATION OF URBAN AND ANIMAL WASTES AS SOURCES OF PHOSPHORUS.

Institut National de la Recherche Agronomique, Station d'Agronomie, 33140 Pont de la Maye, France.

For primary bibliographic entry see Field 3C. W91-10289

SLURRY-METER FOR ESTIMATING DRY MATTER AND NUTRIENT CONTENT OF SLURRY.

Johnstown Castle Research Centre, Johnstown (Ireland).

for primary bibliographic entry see Field 7B. W91-10290

#### Group 5E-Ultimate Disposal Of Wastes

CHEMICAL METHODS FOR ASSESSING BIO-AVAILABLE METALS IN SLUDGES AND SOILS.

nary bibliographic entry see Field 5B.

EFFECT OF INCUBATION ON THE COMPO-SITION OF SOIL SOLUTION DISPLACED
FROM 4 SOILS TREATED WITH ZINC,
COPPER OR NICKEL-LOADED SEWAGE SLUDGE.

Rothamsted Experimental Station, Harpenden (England).

For primary bibliographic entry see Field 5B. W91-10296

FACTORS INFLUENCING HEAVY METAL AVAILABILITY IN FIELD EXPERIMENTS WITH SEWAGE SLUDGES.

Station d'Agronomie, INRA, Domaine de la Grande-Ferrade, 33140 Pont-de-la-Maye, France. For primary bibliographic entry see Field 5B. W91-10297

TREATMENT OF SEWAGE SLUDGE: THER-MOPHILIC AEROBIC DIGESTION AND PROCESSING REQUIREMENTS FOR LAND-FILLING.

For primary bibliographic entry see Field 5D. W91-10328

LANDFILLING OF SEWAGE SLUDGE: PRACTICE AND LEGISLATION IN EUROPE.

HICE AND LEGISLATION IN EUROPE. Eidgencessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland). P. H. Brunner, and T. Lichtensteiger.

P. H. Brunner, and I. Lichtensteiger. In: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 52-57, 2 fig. 1 tab, 16 ref.

Descriptors: \*Europe, \*Land disposal, \*Landfills, \*Sludge disposal, Legislation, Literature review, Regulations, Sludge.

In 15 selected European countries, an average of 43% of all sewage sludge is landfilled. The most common practice consists of stabilization, dewatering, and landfilling in conjunction with municipal solid waste. Only a very few countries regulate sewage sludge landfilling by national legislation. A literature search of Water Resources Abstracts, Environmental Bibliography, and Pollution Abstracts yielded 1026 citations on the agricultural utilization of sewage sludge and only 142 citations on landfilling of sludge. The scarcity of literature on landfilling of sludge is surprising considering the widespread use of this practice in Europe. Studies are lacking on such topics as the short-term and long-term effects of metal and nonmetal pollut-Studies are lacking on such topics as the snort-term and long-term effects of metal and nonmetal pollutants in landfilled sludge. The rare regulations on landfilling of sludge are thus not based on research on the long-term behavior of landfills, but are practical rules to ensure safe operation of the landfill. Additional studies of the biological, chemical, physical and contention of the physical, and geotechnical transformation of the sludge in such a deposit would be appropriate to provide reassurance that sludge landfills have no adverse environmental effects even after long peri-ods of time. (See also W91-10328) (Rochester-PTT) W91-10333

TRANSFORMATION OF SEWAGE SLUDGE IN

LANDFILLS.
Eidgenoessische Anstalt fuer Wasserversorgung,
Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

T. Lichtensteiger, P. H. Brunner, and M Langmeier.

Langineer.

In: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 58-71, 8 fig. 1 tab, 15 ref.

Descriptors: \*Land disposal, \*Landfills, \*Municipal wastes, \*Path of pollutants, \*Sludge disposal,

Biogeochemistry, Diagenesis, Heavy metals, Long-term studies, Organic compounds, Peat, Sludge.

To determine the transformation of sewage sludge to determine the transformation of sewage sludge in the early diagenetic stage, municipal sewage sludge samples from sludge-only landfills of different ages (0-30 yr) were tested for chemical, physical, and geotechnical 'indicator parameters.' The long-term evolution was assessed by comparison of sewage sludge to similar natural sediments (pear, creative cite) and their diseases. Besed on the second control of the sewage sludge to similar natural sediments (peat, organic soils) and their diagenesis. Based on samples from sludge pond landfills, the following hypotheses can be made: (1) in a monolandfill of stabilized sewage sludge, the heavy metals investigated (Zn, Cu, Cd, and Hg) are of only little mobility; (2) there are xenobiotic organic substances that are only partly or not at all degraded in a sludge landfill, even after 10 to 100 yr; and (3) within 100 yr, a liquid sludge-only landfill will reach a geotechnical stability similar to peat or other organic soils. Due to biochemical activities, it is expected that the body of the landfill will it is expected that the body of the landfill will continue to settle for 1000 to 10 million years. (See also W91-10328) (Author's abstract)

LANDFILLING WITH SEWAGE SLUDGE.

LANDPILLING WITH SEWAGE SLUIDES.
P. H. A. M. J. de Bekker, and J. J. van den Berg.
IN: Treatment of Sewage Sludge: Thermophilic
Aerobic Digestion and Processing Requirements
for Landfilling. Elsevier Applied Science, New
York. 1989. p 72-79, 3 fig, 6 ref.

Descriptors: \*Land disposal, \*Landfills, \*Nether-lands, \*Sludge disposal, \*Waste disposal, Air pollu-tion, Biodegradation, Infiltration, Leaching, Rheol-ogy, Sludge, Water pollution, Water pollution con-trol.

In the N therlands there is a decrease in the extent to which sewage sludge is being reused, so it will have to be dumped, incinerated, or disposed of in some other way. Dumping has both physical and chemical aspects. The physical aspects include the mechanical and rheological properties of the sludge, particularly with regard to the stability of a landfill and its bearing capacity for vehicles. Research today focuses on the rheological processing methods. The chemical aspects include the leachability of substances under the influence of infiltrating precipitation, the microbiological decomposition processes by which biogas is formed, and the influence of percolation water on soil and groundwater. Research now focuses on the characterization of leachability and limiting the environmental impact. The emissions to surface water and the atmosphere can be controlled reasonably well In the Natherlands there is a decrease in the extent mental impact. The emissions to surface water and the atmosphere can be controlled reasonably well with existing techniques. (See also W91-10328) (Author's abstract) W91-10335

LANDFILL LEACHATE: OPERATING MO-DALITIES FOR ITS OPTIMAL TREATMENT. Basilicata Univ., Potenza (Italy). For primary bibliographic entry see Field 5D. W91-10336

EXPERIENCES WITH LIMED SLUDGE AS A TOP COVER FOR LANDFILLS.

Chalmers Univ. of Technology, Goeteborg (Sweden).

In: Treatment of Sewage Sludge: Thermophilic Aerobic Digestion and Processing Requirements for Landfilling. Elsevier Applied Science, New York. 1989. p 92-96, 1 tab, 2 ref.

Descriptors: \*Land disposal, \*Landfills, \*Liming, \*Sludge disposal, \*Sweden, Compost, Hydrogen ion concentration, Land reclamation, Nitrogen, Odor control, Organic compounds, Performance evaluation, Sludge, Vegetation, Water pollution control

In the Gothenburg (Sweden) area, dewatered raw sewage sludge is treated with burned lime and limestone. The limed sludge has favorable geotech-nical properties and has been used widely for the construction of embankments and as a top cover

for landfill sites. With a top layer of sludge-bark compost, a vegetation cover can be established rapidly. During the last 10 yr more than 300,000 cu on of limed sludge and sludge-bark compost has been used as an alternative to topsoil as a landfill cover and in other applications, including: top cover for dredged material lagoons, embankment creation, and land reclamation in agriculture. The number of odor complaints from the areas where limed sludge has been used are few. Releases of organics and nitrogen into surface water have been limed sludge has been used are few. Releases of organics and nitrogen into surface water have been observed near landfills covered with limed sludge. The concentrations appear to decrease after the covering operation is finished, but this is being monitored. The oldest limed sludge site is 11 yr old. No visual changes have occurred. PH values have remained high in areas covered with limed sludge. (See also W91-10328) (Rochester-PTT) W91-10337

SEWAGE AND SEWAGE SLUDGE TREAT-MENT.

Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab. For primary bibliographic entry see Field 5D. W91-10409

TREATMENT OF TOXIC WASTES.

Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 5D. W91-10410

SAMPLING PROBLEMS FOR THE CHEMICAL ANALYSIS OF SLUDGE, SOILS AND PLANTS.

For primary bibliographic entry see Field 5A. W91-10461

SAMPLING OF SOILS, HERBAGE, ANIMAL MANURES AND SEWAGE SLUDGE FOR TRACE ELEMENT AND OTHER ANALYSES: IRISH EXPERIENCES.

Johnstown Castle Research Centre, Johnstown (Ireland).

For primary bibliographic entry see Field 5A. W91-10462

SAMPLING AND ANALYSIS OF SLUDGES AND SOILS IN ENGLAND AND WALES FOR THE MANAGEMENT OF AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE.

Severn-Trent Water Authority, Birmingham (Eng-

N. Harkness.

IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Publishing Co., New York. 1986. p 18-26. 8 tab, 7 ref.

Descriptors: \*Agriculture, \*Sludge, \*Sludge analysis, \*Sludge disposal, \*Sludge utilization, Data interpretation, England, Heavy metals, Microorganisms, Nitrogen, Organic compounds, Quality control, Sampling, Severn-Trent Water Authority, Soil analysis, Wales.

The arrangements for control of the agricultural use of sewage sludge by the English and Welsh Water Authorities are outlined with particular refwater Authorities are outlined with particular terence to the Severn-Trent Authority. The main quality aspects of the program are: (1) pathogenic organisms including bacteria and parasites; (2) persistent synthetic organic substances; (3) toxic sistent synthetic organic substances; (3) toxic metals and other inorganic substances; and (4) nutrients, especially nitrogen, with respect to crop requirements and leaching. UK Water Authorities sample sludges for salmonellae from 2 to 9 times per year. The reference standard for further treatment or investigation is 1,000 MPN salmonellae/100 ml. Mean levels of polychlorinated biphenyls (PCBs) and pesticides in sludges from 42 Severn-Trent plants were as follows (mg/kg): PCBs, 0.17; Indane, 0.17; aldrin, not detected; dieldrin, 0.16; and endrin, 0.05. Analyses of inorganic substances normally include Zn, Cu, Ni, Pb, Cr, Cd, and may also include Hg, Mo, B, and F. Within Severn-Trent sludge is classified into low, medium, or high

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metal content with different sampling requirements for each category. A typical medium metal sludge would contain in mg/kg: Zn, 1500; Cu, 700; Ni, 70; Cd, 17-70. Field soil sampling of sludge-amended soils is performed by taking 25 samples per 4 ha along a "W pattern. Fields are sampled before sludge application and resampled every 5 years or after 20% of the recommended 30 year limit quantity. Crop monitoring analyses are generally not performed. Severn-Trent has established a computer database for sludge disposal and field records. In performed. Severn-Trent has established a computer database for sludge disposal and field records. In interpreting the data, changes in methods of analysis and reporting, in sampling, in sludge application methods, and in agricultural practices and site history must be considered. (See also W91-10461) (MacKeen-PTT)
W91-10463

EXPERIENCES WITH SLUDGE SAMPLING IN THE RUHR RIVER BASIN,

For primary bibliographic entry see Field 5A. W91-10464

SOIL SAMPLING FOR TRACE ELEMENT ANALYSIS AND ITS STATISTICAL EVALUATION.

andwirtschaftlich-chemische Bundesanstalt, 4025

Linz, Austria. For primary bibliographic entry see Field 5A. W91-10465

PROBLEMS OF SAMPLING SOIL FAUNA FOR TERRESTRIAL ECOLOGICAL STUDIES, Rijksinstitut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). For primary bibliographic entry see Field 5A. W91-10466

APPLICATION OF DATA ANALYSIS TECH-NIQUES TO SLUDGE AND SOIL SAMPLING OPERATIONS.

Institut de Recherches Hydrologiques, Nancy (France). For primary bibliographic entry see Field 7A. W91-10467

#### 5F. Water Treatment and **Quality Alteration**

FUNDAMENTALS AND TRENDS OF WATER SERVICES IN A NIGERIAN URBAN SETTLE-

Ibadan Univ. (Nigeria). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6C.

LIGHT-SCATTER PARTICLE COUNTING: IM-PROVING FILTERED-WATER QUALITY. Glenmore Waterworks Lab., Calgary (Alberta). C. M. Lewis, and D. H. Manz.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 117, No. 2, p 209-223, March/ April 1991. 4 fig, 7 tab, 31 ref.

Descriptors: \*Drinking water, \*Lighting, \*Particle size, \*Water quality control, \*Water quality monitoring, \*Water treatment, Filtration, Giardia, Microorganisms, Separation techniques, Turbidity, Water quality.

Forward-angle light-scatter (FALS) particle counting is investigated as a means to quantify and improve filtered-water quality in drinking water treatment. In the laboratory, FALS particle counts are precise and reproducible by multiple analysts when proper sample handling procedures are followed. In FALS counts of water samples with added Giardia cysts, FALS categorizes Giardia cysts as equivalent to spheres of 1 to 5 microm in diameter, demonstrating the importance of wine a cysts as equivament to spheres of 1 to 5 micron in diameter, demonstrating the importance of using a particle counter to size particles of interest prior to selecting size ranges for routine monitoring. In full-scale water treatment plant trials, FALS parti-cle counts show that particles in filtered water are substantially reduced when filter operation is

changed from intermittent, fixed rate, 60-hour filter runs to continuously operated, variable rate, filter runs with 48 hours between backwashes. Turbidity measurements follow trends in particle counts in most cases. Further improvements in filtered-water quality can likely be made by using FALS particle counting to optimize backwashing procedures and filter-ripening strategies. (Author's abstract) W91-09387

EVALUATION OF BAT FOR VOCS IN DRINK-

ING WATER.

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5D. W91-09389

ASSESSING THE RELIABILITY OF URBAN RESERVOIR SUPPLIES.
Indianapolis Water Co., IN.
For primary bibliographic entry see Field 6D.
W91-09402

IMPACT OF SURFACE WATER TREATMENT RULE ON GROUNDWATER.

Pirnie (Malcolm), Inc., Newport News, VA. D. J. Hiltebrand, Z. K. Chowdhury, and L. A.

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 52-54, March 1991. 5 fig. 2 ref.

Descriptors: \*Groundwater pollution, \*Ground-water quality, \*Path of pollutants, \*Surface Water Treatment Rule, \*Water quality control, \*Water quality standards, \*Water treatment, Algae, Aquat-ic animals, Contamination, History, Human dis-eases, Human pathogens, Infiltration, Population density, Springs, Surface water, Water supply, Water utilities, Wells.

The Surface Water Treatment Rule (SWTR) requires that all community and noncommunity water supply wells, springs, and infiltration galleries be evaluated to determine whether they are under the direct influence of a surface water. Those groundwater supplies found to be under the direct influence of a surface water will be subject to the SWTR. This determination will have a to the SWTR. This determination will have a significant impact on many existing water utilities and on the development of new supplies. The guidance manual for the SWTR provides a general outline of a procedure that can be used to make the determination of direct influence. The procedure includes a review of the historical records to determine source construction and water quality conditions, distance to nearby surface water, any record of total or fecal coliform contamination, and history of known or suspected waterborne disease out-breaks associated with surface water organisms; an on-site inspection or sanitary survey to look for evidence that surface water can enter through defects; and a particulate analysis to identify organisms that only occur in surface waters, not in groundwaters. The presence of Giardia cysts, live diatoms, algae, Coccidia, and other macroorgan-isms (>7 microm) are considered evidence of direct surface water influence. Particulate analysis ultimately determines, in many cases, whether groundwater supplies are at risk of contamination by macroorganisms such as Giardia cysts. (Brune-PTT)

IS REMEDIATED GROUNDWATER MEETING SDWA REQUIREMENTS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
J. A. Goodrich, B. W. Lyskins, R. M. Clark, and E. T. Oppelt.
Lournal of the American Water Works Association

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 55-62, March 1991. 2 fig, 13 tab, 13 ref.

Descriptors: \*Drinking water, \*Groundwater quality, \*Impaired water quality, \*Impaired water use, \*Safe Drinking Water Act, \*Water pollution treatment, \*Water treatment, Aquifers, Comprehensive Environmental Response Com, Contamination,

Hazardous wastes, Regulations, Site remediation, Water quality monitoring.

Treating groundwater for drinking purposes is quite different from treatment for site remediation. However, given that aquifer cleanup goals are becoming more stringent, drinking water technolobeyoning more stringen, and an area were technique yought to be integrated into groundwater remediation strategies as a final polishing step and as a means of meeting the requirements of the Safe Drinking Water Act (SDWA). Many of the contaminants to be regulated under the SDWA are the same as those on the Comprehensive Environmensame as those on the Comprehensive Environmental Response Compensation and Liability Act. Even if most of a contaminant is removed from groundwater or soil, the risk to drinking water from the soil remains or concentrations of the contaminant may remain in the groundwater and must be removed to satisfy federal and state drinking water regulations. Traditional drinking water treatment technologies could be used to deal with hazardous waste sites, including cost, performance, and applicability. Promising technologies for groundwater treatment include particulate activated carbon, ozone oxidation, reverse osmosis, ion ed carbon, ozone oxidation, reverse osmosis, ion exchange, and ultraviolet treatment. Pump and treat technology as used in drinking water applications involves pumping a portion of the water out of the aquifer and treating it for human consump-tion. Currently, there are few hazardous sites where in situ treated groundwaters have actually been used for drinking water purposes, even though nearly two-thirds of all Superfund sites involve a contaminated drinking water supply. (Brunone-PTT) W91-09404

VARIATIONS IN ORGANIC AND ORGANO-LEPTIC WATER QUALITY DURING TREAT-MENT OF ARTIFICIALLY RECHARGED GROUNDWATER.

Lyonnaise des Eaux, Le Pecq (France). Lab. Cen-

A. Bruchet, K. N'Guyen, M. F. Legrand, and J. Mallevialle.

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 63-70, March 1991. 7 fig, 5 tab, 10 ref.

Descriptors: \*Artificial recharge, \*France, \*Groundwater quality, \*Water quality control, \*Water treatment, Aquifers, Drinking water quality, Odors, Organic loading, Organoleptic proper-ties, Regression analysis, Statistical analysis, Taste, Upstream, Wastewater treatment facilities.

The operation of the first artificial recharge process in France was begun in Croissy (west of Paris) in 1959 to solve the problems of decreased aquifer volume and lower water quality. The Croissy and Le Pecq facilities are located upstream of the Acheres wastewater treatment plant, which treats about 50% of the effluents from the Paris area; thus the raw water used for the recharge is practically upstream of the collection of the process of the technique to the process of cally unaffected by wastewater discharges. The Le Pecq and Croissy plants provide drinking water to a population of approximately 500,000 people at a rate of 150,000 cubic m/day from 27 boreholes that pump water from the Croissy limestone aquifer. Samples were collected at intervals of three weeks Samples were collected at microaus of three weeks from a number of sites: recharge water at the outlet of the Croissy recharge plant, raw groundwater, nitrified water, ozonated water, granular activated carbon filtered water, and chlorinated water. Statistical analysis was performed by factorial correspondence analysis, which allows quick extraction of essential information contained in a vast set of data. Factorial correspondence analysis also allows prediction by the use of stochastic regression models. The treated surface water that is used to recharge the Croissy aquifer is characterized by earthy-musty tastes and odors of average to high intensity. The recharge process significantly improved the organic and organoleptic quality of the water. Both the dissolved organic carbon content and the earthy-muddy tastes and odors decreased through the slow infiltration through the sand pits. Subsequent treatment at the Le Pecq Minor plant further improved the organoleptic quality of the water, and the low-intensity tastes and odors detected in the finished drinking water

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are unlikely to be perceived by untrained consumers. The improvement in organoleptic quality cannot be related to a change in the load of volatile organics in general, but to the fate of specific compounds during the various treatments in-volved. (Brunone-PTT)

IMPACT OF OZONATION ON PARTICLE STABILITY AND THE REMOVAL OF TOC AND THM PRECURSORS.

CH2M Hill, Santa Ana, CA.
S. D. Chang, and P. C. Singer.
Journal of the American Water Works Association
JAWWA5, Vol. 83, No. 3, p 71-75, March 1991. 11 fig, 6 tab, 59 ref.

Descriptors: \*Disinfection, \*Drinking water, \*Organic carbon, \*Ozonation, \*Trihalomethanes, \*Water treatment, Hardness, Particle stability, Particulate matter, Water treatment facilities.

Ozonation as an oxidant and primary disinfectant is Ozonation as an oxidant and primary disinfectant is becoming increasingly attractive, because it has been reported to behave as a coagulant aid during the treatment of raw drinking water. The capabilities of ozone to meet desired treatment objectives have been evaluated in three areas: the performance of several water treatment facilities that have adopted preozonation as an alternative to prechlorination; the impact of ozone on the removal of particulate material, total organic carbon (TOC) and trihalomethane (THM) precursors by conventional water treatment; and the effect of ozone on particle stability. Waters from seven utilities that use ozone as a preoxidant were analyzed to deter mine the impact of ozone on the removal of TOC mine the impact of ozone on the removal of 100-and THM precursors and on the collision efficien-cy factor and electrophilic mobility of suspended particles in the water. Water quality characteristics that favor the use of ozone as a coagulant aid were identified. Preozonation lowered THM formation potential by about 10% at the dosages commonly potential by about 10% at the disagges commonly used in practice, and optimal ozone-induced particle destabilization was found to occur in waters with hardness: TOC ratios >25mg calcium carbonate/mg carbon and ozone doses of about 0.4 to 0.8 mg ozone/mg carbon. (Brunone-PTT) W91-09406

#### TRIHALOMETHANE FORMATION IN OPEN RESERVOIRS

Los Angeles City Dept. of Water and Power, CA. For primary bibliographic entry see Field 5B. W91-09408

### FORMATION OF NON-VOLATILE POTENT MUTAGENS IN DOMESTIC SEWAGE BY CHLORINATION.

Kyoto Pharmaceutical University, Yamashina-ku, Kyoto, Japan, 607. bibliographic entry see Field 5D. For primary W91-09435

### GASTROINTESTINAL HEALTH EFFECTS AS-SOCIATED WITH THE CONSUMPTION OF DRINKING WATER PRODUCED BY POINT-OF-USE DOMESTIC REVERSE-OSMOSIS FIL-TRATION UNITS.

Institut Armand-Frappier, Laval (Quebec). P. Payment, E. Franco, L. Richardson, and J. Siemiatycki.

Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 4, p 945-948, April 1991. 3 tab. 18 ref.

Descriptors: \*Bacterial growth, \*Drinking water, \*Filtration, \*Human diseases, \*Reverse osmosis, \*Water treatment, Bacterial analysis, Correlation polysis, Domestic water Faidenialogy, Hatter analysis, Domestic water, Epidemiology, Hetero-trophic bacteria, Microbiological studies, Temper-

During the course of a prospective epidemiological study of the gastrointestinal health effects of drinkstudy of the gastromestimal neather elects of drink-ing water, reverse-osmosis (RO) water filtration units were installed in randomly chosen house-holds. Analysis of the bacterial content of the water filtered by these units revealed the presence

of very high total bacterial counts in most units. Univariate correlations between the rate of gastro-intestinal illness and the heterotrophic plate count (HPC) at 35 and 20 C were both significant at the 5% level, suggesting that bacteria growing in the filtration units were responsible for an increase in the incidence of gastrointestinal symptoms. There was no correlation between the number of days sick and the HPCs at 20 C, but there was a positive correlation with the number of bacteria at 35 C This means that the symptoms observed tended to be more severe as the bacterial counts at 35 C increased. Other variables, such as family size and amount of water consumed, were not explanatory of the rate of illness. These observations raise concerns about the safety of such point-of-use devices for domestic use and emphasize the impor-tance of controlling bacterial growth in drinking water. (Doria-PTT)

# DEVELOPMENT OF A WATER SUPPLY OP-ERATION MODEL FOR THE CITY OF NORTHGLENN, COLORADO.

For primary bibliographic entry see Field 7C. W91-09575

BIOASSAY PROCEDURE FOR PREDICTING COLIFORM BACTERIAL GROWTH IN DRINKING WATER. Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. For primary bibliographic entry see Field 5A. W91-09659

### FEASIBILITY STUDY OF DECHLORINATION OF CHLOROFORM IN WATER BY ULTRASOUND IN THE PRESENCE OF HYDROGEN PEROXIDE.

PEROXIDE. University of Southern California, Los Angeles. Dept. of Civil Engineering. J. R. Chen, X. W. Xu, A. S. Lee, and T. F. Yen. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 829-836, 1990. 2 fig, 4 tab, 20 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Dechlorination, \*Drinking water, \*Hydrogen peroxide, \*Trihalomethanes, \*Ultrasonics, \*Water treatment, Chlorination, Chloroform, Iron, Kinetics, Methanol, Water quality.

The existence of trihalomethanes (THM) in chlorinated drinking water is a major concern due to their potential hazard to human health. A procetheir potential hazard to human health. A procedure for the dechlorination of chloroform, the predominate THM, in water using ultrasound in combination with hydrogen peroxide was developed. Decomposition is accomplished by a first-order free-radical reaction with the optimal hydrogen peroxide concentration measured at a molar ratio of H2O2:CHCl3 = 50:l. Ferrous ions (20 mg/L) increase while methanol addition decreases the versall reaction efficiency. Under continual condi-L) increase while methanol adoltion decreases the overall reaction efficiency. Under optimal conditions the removal of chloroform by this method approaches 94%. A kinetic plot for the removal of chloroform by ultrasound in the presence of H2O2 and Fe(++) was linear. This plot indicates that the reaction appears to be a first order reaction with a rate constant of 0.0177/min. (D'Agostino-TTTT)

# PHOTOSONOCHEMICAL DECOMPOSITION OF AQUEOUS 1,1,1-TRICHLOROETHANE. Carter Analytical Lab., Inc., Campbell, CA. M. S. Toy, M. K. Carter, and T. O. Passell.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 837-842, 1990. 1 fig, 2 tab, 16 ref. Electric Power Research Institute, Contract 2997-

Descriptors: \*Chemical degradation, \*Chlorinated hydrocarbons, \*Photolysis, \*Sonolysis, \*Trichloroethane, \*Water treatment, Corrosion, Gas chromatography, Infrared spectroscopy, Ion exchange chromatography.

The intrusion of organic contaminants into water flow systems is a major concern of the nuclear

power industry since this leads to equipment corrosion amd increased radioactive waste. An industrial process in which the haloalkane, 1,1,1-trichloroethane, is removed from aqueous solutions was developed. The extent of decomposition was measured by gas chromatography for removal of CCl3CH3, a turbidometric procedure for produc-tion of chloride ions, and Fourier transform infranon or chloride ions, and Fourier transform intra-red spectroscopy for solid product, 1,1,1-trichlor-oethane is more extensivly degraded by a combina-tion of both photolysis and sonolysis procedures than with each separately. The corrosive chloride anions can be subsequently removed by the plant's existing ion-exchange equipment. (D'Agostino-W91-09661

### REMOVAL OF HUMIC ACIDS BY THE PROC-ESS OF FLOCCULATION-ULTRAFILTRA-ESS OF TION.

Hiroshima Univ. (Japan). Dept. of Environmental

X. C. Zhang, M. Masumoto, H. Sunahara, and A. Akazawa.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 11, p 1007-1014, 1990. 10 fig, 2 tab, 15

Descriptors: \*Drinking water, \*Flocculation, \*Humic acids, \*Sedimentation, \*Ultrafiltration, \*Water treatment, Chlorination, Polyaluminum chloride, Polyelectrolytes, Total organic carbon, Trihalomethanes, Water quality.

The general treatment for the production of drink-The general treatment for the production of drink-ing water consists of coagulation, sand filtration, and chlorination. The pollutant, humic acid (HA), as a potential precursor of trihalomethane, must be removed before the chlorination process. The re-moval of HA from water in a laboratory scale plant by flocculation-sedimentation and flocculation-ultrafiltration (UF) using polyaluminum chloride (PAC) and a polyelectrolyte (PE) was investigated. TOC removal and decline of E260 (absorbance at 260 nm) were used as experimental indicabance at 260 nm) were used as experimental indica-tors. TOC removal was 88.5-90.4% by coagulation with PAC and 90.3-91.1% by flocculation with PAC and PE at a pH of 6.8-7.2. For the UF process, flat sheet membranes with molecular weight cut offs (MWCO) of 104, 105, and 106 were weight cut offs (MWCO) of 104, 105, and 108 were used. The solutions were applied to the UF module at an input pressure of 0.2 MPa and a circulation flow rate of 250 ml/min. TOC removals for an HA solution of 50 mg/L increased from 78.3% to 93.8% with decreasing MWCO. For the mixed HA solution containing PAC flocs, TOC removal HA solution containing PAC flocs, 10C removal by the 106 MWCO membrane was 90.5%. For the solution of HA, PAC, and PE, the TOC removal was 90.5%, 92.5%, and 95.4% for the 106-104 MWCO membranes, respectively. The flocculation-sedimentation process resulted in 88.9% TOC removal and 89.5% reduction in E260. The flocculation is peaked save 80.6% TOC removal city. lation UF method gave 89.6% TOC removal with a decline of 91.9% of E260, using the 106 MWCO membrane at a permeation flux of 249.2 L/h.sq m. (D'Agostino-PTT) W91-09675

# STIMULATION OF MULTICOMPONENT SORPTION PROCESSES WITH AXIAL DIFFU-

Jordan Univ. of Science and Technology, Irbid. Dept. of Chemical Engineering. For primary bibliographic entry see Field 5D.

### MONITORING SYSTEM DETECTS SMALL

Syndicat des Eaux d'Ile de France, Paris, France For primary bibliographic entry see Field 8G. W91-09770

#### MODEL FOR SAVING RESOURCES.

WRc Inc., Huntington, PA. S. Whipp, and B. Pressdee.

Water Engineering and Management WENMD2, Vol 138, No. 2, p 16-17, February 1991. 1 fig.

### Water Treatment and Quality Alteration—Group 5F

Descriptors: \*Computer models, \*Management planning, \*Model studies, \*Network design, \*Planning, \*Model studies, \*Water distribution, \*Water use, Camden, Computer programs, Delaware, Leakage, New Jersey, Pipes, Pumps, Reservoirs, Storage, Valves, Water mains, Water metering, Storage, Va Wilmington.

A network model was developed for Camden, New Jersey's water distribution system and calibrated using data collected with novel field measurement equipment. The model was used to preurement equipment. The model was used to pre-dict future demands with and without potential exports from the system. A detailed infrastructure investment program and business plan was devel-oped for the distribution network including re-placement mains, additional valves, modification to pumps, and provision of additional storage capac-ity. The project also set target dates. In the net-work model used in Camden and also in Wilming-ton Delawater a geometric layout of nodes and ton, Delaware, a geometric layout of nodes and branches represents the actual water network. All branch features must be specified with an inlet and outlet node. Pipes are assumed to be uniform in diameter, roughness, and gradient. Pumps can be source or booster pumps, fixed or variable in speed. Several valve types can be modeled. Traditional network analysis provides a snapshot of the network. Network simulation describes network operation over time. Such simulation helps engineers address operational aspects such as detailed pump simulation, assessment of diurnal effects of demand and operation, estimation of reservoir perdemand and operation, estimated of reservor per-formance, and comparison of actual and simulated values of supply and distribution. Supervisory soft-ware will allow different sequences of network simulation to be executed on demand. (Doria-PTT) W91-09772

COLLECTING FIELD DATA FOR A HYDRAU-

GRW Engineers, Lexington, KY.
For primary bibliographic entry see Field 7A.
W91-09773

#### LATEST STUDY FINDS UTILITIES SATISFIED WITH OZONE.

Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA. . H. Tate.

C. H. Tate. Water Engineering and Management WENMD2, Vol 138, No. 2, p 24-25, February 1991. 1 fig, 1 tab.

Descriptors: \*Disinfection, \*Odor control, \*Ozonation, \*Ozone, \*Water treatment, Canada, Coliforms, Cooling, Corrosion, Filtration, Iron, Maintenance, Manganese, Organic carbon, Pesticides, Pretreatment of water, Regulations, Sedimentation, Surveys, Taste, Training, Trihalomethanes, Tubes, Turbidity, United States, Water quality.

Ozone is viewed as one of the more viable water treatment technologies to solve water quality probtreatment technologies to solve water quanty prot-lems pertaining to disinfection, disinfection by-products, taste and odor, color, pesticides, iron, and manganese without forming chlorinated by-products. A recent study examined the perform-ance and trends in ozone plants in the United States and Canada. Most plants apply ozone in pretreatment; other application points include post-sedimentation and post-filtration. Half the plants sedimentation and post-nitration. Half the plants use ozone in pretreatment as the only application point due to good water quality. If the water has low turbidity, total organic carbon and coliform count, ozone demand is low and the dose required at pretreatment may not vary substantially from that downstream. Corrosion was noted in several components including dryers, generators, and tubes holding diffusers in contactors. For air feed systems in warm climates, experienced users sugtubes holding diffusers in contactors. For air feed systems in warm climates, experienced users suggested adding a refrigerant dryer and a chilled water cooling system. To help prevent dust from reaching ozone generators, users suggested installing filters following the desiccant dryers in air feed systems. Users found that, with ozone technology, it is important to train operations and maintenance staffs. The Environmental Protection Agency's staffs. The Environmental Protection Agency's rules regarding trihalomethanes are expected to prompt many more plants to use ozone by the year 2000. (Doria-PTT) W91-09774

FATE OF HUMAN ENTERIC VIRUSES, COLI-PHAGES, AND CLOSTRIDIUM PERFRIN-GENS DURING DRINKING-WATER TREAT-MENT.

Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.

r. rayınent. Canadian Journal of Microbiology CJMIAZ, Vol. 37, No. 2, p 154-157, February 1991. 2 tab, 25 ref. Grant NHRDP 6605-2556-54 and Natural Sciences and Engineering Research Council of Canada Grant A6211. P. Payment.

Descriptors: \*Clostridium, \*Coliphages, \*Drinking water, \*Enteroviruses, \*Human pathogens, \*Water quality control, \*Water treatment, Alum, Disinfection, Flocculation, Microorganisms, Potable water, Water quality, Water sampling.

The elimination of human enteric viruses, coli-phages, and Clostridium perfringens was investiphages, and Clostridium perfringens was investigated during a conventional complete drinking water treatment process. The respective concentrations (geometric mean) of these microorganisms in 100 L samples of river water were, respectively-viruses, 79 mpniu (most probable number of infectious units) per 100 L, coliphages, 6565 pfu (plaque-forming units) per 100 L, and clostridia, 11,349 cfu (colony-forming units) per 100 L. After pre-disinfection, flocculation with alum, and settling, human enteric viruses were not detected in any of the 100 L samples (<4 mpniu/100 L), but coliphages were detected in 2 of 31 samples, coliphages in 10 of 33, and clostridia in 17 of 33. Finished water was free of human enteric viruses (0 of 162 samples), but coliphages were detected in (0 of 162 samples), but coliphages were detected in one sample (1.5 pfu/100 L) and clostridia in three, at 1.0, 4.1, and 7.0 cfu/100 L. These results indicate that clostridia and coliphages, which are present in larger numbers than viruses in river water and which may have similar resistance to drinking water treatments, may be useful for estimating the level of treatment attained when large volumes of water (1000 L or greater) are sampled. (Author's abstract) W91-10006

### PHILOSOPHICAL AND CULTURAL CON-CEPTS UNDERLYING WATER SUPPLY IN ANTIQUITY.

Newcastle Univ. (Australia). Dept. of Classics. R. G. Tanner.

In: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987, p 27-35, 19 ref.

Descriptors: \*Attitudes, \*History, \*Social aspects, Descriptors: Attitudes, "History, "Social aspects, "Water policy, "Water resources management, Aqueducts, Pipes, Potential water supply, River management, Rome, Springs, Water control, Water conveyance, Water resources development, Water supply development, Water use.

In 1935 Thomas Ashby remarked in his major work, 'Aqueducts of Ancient Rome', that the Roman policy of preferring free-flowing fountains to conservation of a reserve supply of water implied a different philosophy of water usage and of public utility from that current in modern times. public utility from that current in modern times. Ancient men found a mystery in the origin of springs. Especially providential seemed the perennial springs found on top of hills suitable for fortification as refuges by bronze or iron age men. Such water was the gift of the tutelary tribal god inhabiting that strong place, and therefore sacred. Even as civilization advanced, inherited inhibitions still offected men who believed less deals in supers. as civilization advanced, inherited inhibitions still affected men who believed less deeply in nympho of the spring or gods of the rivers. Thus dislike of pipes and syphons, the creation of aqueducts as gravitational artificial river beds, and the free release of much water in fountains all seem reflections of such an attitude. In addition, Hippocratic studies of the medicinal properties of various waters and Thales' speculations about water as the basic substance and spontaneous source of life all served to reinforce this value system underlying imperial Roman supply practice and the technical imperial Roman supply practice and the technical manual of Frontius. (See also W91-10103) (Author's abstract) W91-10107

EFFECT OF A SELF-REGULATING TRACE HEATING ELEMENT ON LEGIONELLA WITHIN A SHOWER.

Liverpool Univ. (England). Dept. of Medical Microbiology.

T. Makin, and C. A. Hart.

Journal of Applied Bacteriology JABAA4, Vol. 70, No. 3, p 258-264, March 1991. 2 fig, 2 tab, 27

Descriptors: \*Domestic water, \*Heated water, \*Legionella, \*Pathogenic bacteria, \*Water treatment, Heating elements, Microbiological studies, Temperature effects.

A self-regulating trace heating element was assessed for its ability to maintain a temperature of 50 C in the mixer valve and dead-legs of a shower, and for its effect on legionellas colonizing the shower. The trace heating element maintained a temperature of 50 C in dead-legs when the circulating hot water supply remained above 45 C. Legionellas appeared in a trace heated dead-leg when the temperature of the dead-leg reached 45 C and the hot water supply dropped below this temperature. Legionellas were eradicated or significantly reduced in sections of the shower where a temperature of 50 C was consistently achieved. a temperature of 50 C was consistently achieved. The mixer valve which was trace heated but not insulated remained colonized with Legionellas. Legionellas were found in shower water throughout the study. (Author's abstract) W91-10211

# MEMBRANE FILTER PROCEDURE FOR AS-SAYING CYTOTOXIC ACTIVITY IN HETERO-TROPHIC BACTERIA ISOLATED FROM DRINKING WATER.

Environmental Monitoring Systems Lab., Cincin-

For primary bibliographic entry see Field 5A. W91-10231

#### POINT-OF-USE TREATMENT OF DRINKING WATER IN SAN YSIDRO, NM.

Leedshill-Herkenhoff, Inc., Albuquerque, NM. K. R. Rogers.

Available from the National Technical Information Avanaore from the National Technical Information Service, Springfield, VA. 22161, as PB90-108838. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/2-89/050, October 1989. 65p, 9 fig. 12 tab, 6 append. EPA Cooperative Agreement No. CR-812499-01.

Descriptors: \*Drinking water, \*New Mexico, \*Point-of-use water treatment, \*San Ysidro, \*Water treatment, Arsenic, Bacteria, Chlorides, Dissolved solids, Fluorides, Iron, Manganese, Performance evaluation, Reverse osmosis, Water qual-

A study was conducted to determine whether point-of-use reverse osmosis units could satisfactorily function in lieu of central treatment to remove arsenic and fluoride from the drinking water supply of a small community. Point-of-use treat-ment was evaluated for removal efficiency, cost, and management effectiveness. The community involved in this study, San Ysidro, New Mexico, averaged arsenic concentrations of 0.059 mg/L and fluoride concentrations of 2.7 mg/L during the project period. Seventy-eight under the sink model reverse osmosis units with polyamide membranes were installed during the project. The reverse osmosis units attained 86% arsenic removal and 87% moss units attained 30% areasen removal and 37% effuoride removal during the 20 month project period. The units were evaluated for removal of chloride, iron, manganese, total dissolved solids (TDS) and bacteria as well. The reverse osmosis units were effective in removal of chloride, iron, manganese and TDS to below the recommended manganese and TDS to below the recommended maximum chloride levels, but the removal percentages were approximately 10% less than those stated in the manufacturer's literature. This discrepancy was more than likely due to the quantity and combination of contaminants in the San Ysidro waters wently (Authorite obstracts). water supply. (Author's abstract) W91-10250

### Group 5F-Water Treatment and Quality Alteration

HEALTH EFFECTS OF AGRICHEMICALS IN GROUNDWATER: WHAT DO WE KNOW. National Cancer Inst., Bethesda, MD. Environmental Epidemiology Branch. For primary bibliographic entry see Field 5C. W91-10390

WATER QUALITY AND HEALTH. For primary bibliographic entry see Field 5C. W91-10411

### 5G. Water Quality Control

SALINITY AND BORON TOLERANCES OF CANDIDATE PLANTS FOR THE REMOVAL OF SELENIUM FROM SOILS.

California Univ., Riverside. Dept. of Soil and En-

D. R. Parker, A. L. Page, and D. N. Thomason. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 157-164, January/March 1991. 1 fig, 6 tab, 35 ref.

Descriptors: \*Agricultural runoff, \*Bioremedia-tion, \*Boron, \*Salinity, \*Selenium, \*Water pollu-tion treatment, Adsorption, Alfalfa, Bioaccumula-tion, Decontamination, Germination, Plants, Saline soils, Salt tolerance, Soil chemistry, Sporobolus

Agricultural water from the west side of the San Joaquin Valley, CA is highly salinized, and often contaminated with an assortment of metals and metalloids, including Se. Among proposed disposal options, vegetation management may be a critical component of remediation strategies designed to reduce soil or sediment concentrations of Se to safe levels. Soil salinity (mostly sodium sulfate) and B pose serious limitations to the use of many plant species from the genera Astragalus, Leucaena, Me-dicago, Psathyrostachys, Puccinellia, and Sporobo-lus for tolerance to salinity and B using solution dicago, Psathyrostachys, Puccinellia, and Sporoblus for tolerance to salinity and B using solution
culture methods. Considerable variation in tolerance to salinity, both within and across species,
was observed during seed germination. Electrical
conductivities required to produce a 50% reduction in germination ranged from 5-30 dS/m, Boron
levels up to 4.0 mM had only minimal effects on
germination. The most promising genotypes, representing some 15 species, were then tested for salinity and B tolerance during the seeding growth
stage. Lines of five species (Astragalus bisulcatus,
A. racemosus, Elytrigia pontica, Puccinellia distans, and Sporobolus airoides) appeared most
promising; all exhibited electroconductivity germination reduction values of > 20 dS/m and were
unaffected by B concentrations up to 4.0 mM
during seeding growth. Astragalus bisulcatus and
A racemosus are considered primary accumulators
of Se; their tolerance of high salinity and B during
seeding growth make them particularly good candidates for remediation of Se-enriched soils and
sediments. (Author's abstract)

WATER QUALITY IMPACTS ASSOCIATED WITH SORGHUM CULTURE IN THE SOUTH-

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 4C. W91-09351

WATER QUALITY IMPACTS ASSOCIATED WITH WHEAT CULTURE IN THE SOUTHERN

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. For primary bibliographic entry see Field 4C. W91-09352

REDUCTION OF NITRATE IN AQUIFER MI-

REDUCTION OF NITRATE IN AQUIFER MI-CROCOSMS BY CARBON ADDITIONS, National Aeronautics and Space Administration, Houston, TX. Lyndon B. Johnson Space Center. D. C. Obenhuber, and R. Lowrance. Journal of Environmental Quality JEVQAA, Vol. 20, No. 1, p 255-258, January/March 1991. 2 fig, 2

tab, 23 ref.

Descriptors: \*Aquifers, \*Biological treatment, \*Denitrification, \*Nitrates, \*Nitrogen removal, \*Water pollution treatment, Biodegradation, Carbon, Groundwater chemistry, Groundwater pollution, Microbial degradation.

Elevated nitrate levels which pose a potential health threat, can occasionally be found in areas where groundwater recharge is affected by agri-cultural runoff. The development of economical methods for reducing nitrate concentrations is, therefore, a high priority. Aquifer microcosms were used to examine the effects of NO3(-) and C were used to examine the effects of NO<sub>3</sub>(-) and C amendments, in the form of glucose, on groundwater from the Claiborne aquifer. Nitrate concentrations of 12.17 mg/L in aquifer microcosms were reduced 0.92%/d to 5.84 mg/L, by the addition of 10 mg C/L for 35 d. Nitrate disappearance correlated with increases in the number of dentitifiers and discounts NO<sub>2</sub> concentration and denote the control of the contro and dissolved N2O concentration and decreases in and dissolved NAO concentration and oecreases in dissolved oxygen, suggesting biological denitrification. Because chloride is not metabolized, nitrate/
chloride ratios, used as an indicator of NO3c)
disappearance, decreased in microcosms with 10 mg C/L added and then increased when the C addition was removed. Carbon additions of 0.4 mg
C/L had no effect on the microbial or chemical properties of the microcosms. Nitrous oxide levels properties of the microcosms. Nitrous oxide levels properties of the microcosms. Nitrous oxide levels in wells sampling the Claiborne aquifer showed an increase with depth, indicating N2O production within the aquifer. Microcosms are useful tools to examine biological transformations of chemical contaminants in unconsolidated aquifer material. The remediation of N03(-) contaminated aquifers by organic infusion is possible and appears to be a function of microbial denitrification. (Author's abstract) W91-09354

WATER MANAGEMENT OF THE RIVER RHINE: PAST, PRESENT AND FUTURE. Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).

For primary bibliographic entry see Field 4A. W91-09374

CLEANER PRODUCTION: THE MOST EFFEC-TIVE APPROACH TO ACHIEVING IM-PROVED WATER QUALITY.

Erasmus Univ., Rotterdam (Netherlands). Studie-centrum voor Millieukunde.

D. Huisingh, and L. W. Bass. European Water Pollution Control, Vol. 1, No. 1, p 24-30, January 1991. 2 tab, 7 ref.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial production, \*Sweden, \*The Netherlands, \*Water pollution control, \*Water pollution sources, Economic aspects, Environmental effects, Interagency cooperation administrative agency, Water pollution, Water quality.

Water quality improvement programs are becomwater quanty improvement programs are becoming increasingly urgent as new regions are found within which surface water and groundwater have become severely contaminated. Approaches to pollution control during the last two decades have helped to reduce the direct discharge of some pollutants from point sources, but far too often the subtleme region ferms the subtleme region for the problems arising from the pollutants were not solved, as the materials were merely transferred to another medium. Because of the inadequacies of placing almost sole reliance upon 'end-of-pipe' pollution control, some corporations are demonstrat-ing that a more integrative and preventive ap-proach (called Cleaner Production (CP)) based upon the elimination or minimization of the problems at their sources, is technically possible, envi-ronmentally more beneficial, and economically more profitable. Under CP, corporate leaders are challenged to address all aspects of the entire life-cycle of their products including: (a) the product design phase; (b) the selection of raw materials; (c) the production of raw materials; (d) the production the production of raw materials; (d) the production and assemblage of the final products; (e) consumer use of the products; and (f) the management of all used products at the end of their useful life. Environmentally and economically encouraging results of experiments with four industrial firms in

Sweden (Landskrona) and The Netherlands (three companies in Project Industriele Successen Met Afvalpreventie) are illustrative of the multimedia benefits realized by these firms using CP approachbenetis realized by these firms using CP approach-es. Governments at all levels are encouraged to foster this pollution prevention approach within industry by providing technical assistance pro-grams for waste reduction-pollution prevention to help corporate leaders move conceptually and pro-cedurally to the preventive approaches of CP. (Brunone-PTT)

### RESTORATION OF EUTROPHIED SWISS

Water Pollution Control Office of the Canton of Zurich, Walchetor, CH-8090, Zurich, Switzerland. B. Jost, P. Leumann, P. Liechti, and P. Stadelman

European Water Pollution Control, Vol. 1, No. 1, p 31-41, January 1991. 15 fig, 6 tab, 6 ref.

Descriptors: \*Algal blooms, \*Algal growth, \*Eutrophication, \*Lake restoration, \*Limiting nutrients, \*Switzerland, \*Water pollution control, Aeration, Agriculture, Aquatic habitats, Contact filtration, Effluents, Epilimnion, Nutrient concentrations, Precipitation, Separation techniques, Water

Between 1960 and 1980 some Swiss lakes became heavily eutrophied. The circulation concentration heavily eutrophied. The circulation concentration reached values as high as 500 mg/cubic m. Algal growth was abundant, but clearly phosphorus-limited, and at times even light-limited. For periods of up to six months, no dissolved oxygen was measured in the hypolimnion. Main sources of nutrient input were sewage and losses from agriculture and, due to anaerobic conditions, redissolution from the sediments. The first measures to reduce phosphorus input were taken in the early sixties by equip-ping sewage treatment plants with simultaneous precipitation, followed by contact filtration. In this way, an effluent standard of 0.2 mg P/L was precipitation, followed by contact filtration. In this way, an effluent standard of 0.2 mg P/L was reached in the early eighties. In the same period, an accompanying action was started to reduce the input from agriculture. As from 1986, a ban on phosphorus in textile-washing powders was in operation, and proved to be efficient. Circulation concentrations of phosphorus have been reduced to less than 20% of the earlier peak values. For some lakes, the reduction is still not sufficient to reach the quality criterion. Further measures have to follow, including an internal restoration of the lakes. Acration can enlarge the habitat for fish. As lakes. Aeration can enlarge the habitat for fish. As long as abundant nutrients are available within the epilimnion, algal production will continue. As a result, the amount of organic matter sinking to the sediment remains high, and conditions right above the sediment surface will stay anaerobic. Destratification and aeration are measures only feasible to fight symptoms. Drastic measures concerning agriculture such as reducing the number of cattle and pigs, as well as combatting soil erosion, have become unavoidable. (Brunone-PTT) W91-09377

### STATE OF WATER ENVIRONMENT IN HUN-

Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).

L. Somlyody, and B. Hock. European Water Pollution Control, Vol. 1, No. 1, p 43-52, January 1991. 7 fig, 6 tab, 17 ref.

Descriptors: \*Hungary, \*Surface water, \*Water demand, \*Water resources management, Agricultural water, Anaerobic conditions, Bank infiltration, Economic aspects, Groundwater, Industrial water, Organic matter, Salinity, Subsurface water, Water pollution control, Water quality monitoring, Water quality trends, Wells.

Some 94% of the surface water available in Hungary in August (within an 80% probability) originates from abroad. Between 1970 and 1985 the water demand doubled (reaching the value 6,000,000,000 cubic m/year) but a lesser rate of increase is expected up to the year 2000. The most significant water user is industry, followed by agri-

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cultural and communal water demands. About half cultural and communal water demands. About half of the latter demands is met by utilizing bank-filtered water resources. The rivers Kapos, Zagyva and Zala are characterized by a continuously deteriorating water quality, with the partial exception of the components of the oxygen household. Due to increased locals of organic matter on the bottom continuous of the Resease Donaha care which here to increased loi. so forganic matter on the bottom sediment of the Rackeve Danube arm, which has fair oxygen supply conditions, near anaerobic conditions are developing in some of the wells. This condition can result in the increase of iron, manganese and ammonia concentrations in the well waters. The quality of other subsurface waters which have a natural protection, is stable; karstic waters. The quality of other subsurface waters which have a natural protection, is stable; karstic and other groundwater resources, having no protection against pollution from the surface, exhibit deteriorating water quality trends. Problems related to high salt, gas (methane), iron and arsenic concentrations in the groundwater occur with different magnitude in various regions of the country. The future quality of Hungary's waters will be determined to a large extent by the following factors: (1) the growing importance of non-point source pollution; (2) the increasing levels of pollution registered in the bottom sediments of Hungary's major rivers and in its groundwaters; (3) the growing number of pollution accidents; (4) the difficulties in estimating future water quality because of impacts from delayed effects; (5) the problems caused by the combined effects of several pollutants; (6) the emergence of regional water-quality problems that call for trans-boundary solutions; and (7) the effectiveness of the new socioeconomic system in Hungary. (Brunone-PTT)

WATER-QUALITY IMPACT ASSESSMENT FOR HYDROPOWER. HYDROEXYGIANTIKI, Evias 3, 15125 Mar-

ousi, Greece oust, offeece.
E. I. Daniil, J. Gulliver, and J. R. Thene.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 117, No. 2, p 179-193, March/
April 1991. 6 fig, 1 tab, 19 ref.

Descriptors: \*Dam effects, \*Data acquisition, \*Environmental effects, \*Hydroelectric plants, \*Water quality, \*Water quality management, \*Water resources development, Aeration, Dissolved oxygen, Economic aspects, Field tests, Licensing, Prediction, Spillways, Turbines.

Studies to evaluate the impact of hydropower facilities or downstream water quality, are frequently mandated for hydropower licensing by local, state and/or federal agencies. Negative impacts can result from the substitution of discharges aerated over a spillway, with minimally aerated turbine discharges that are often withdrawn from lower reservoir levels where dissolved oxygen is typicalreservoir levels where dissolved oxygen is typical-ly low. Historic data are used to establish the probability of low dissolved oxygen occurrences. Synoptic surveys, combined with downstream monitoring, give an overall picture of the water quality dynamics in the river and the reservoirs; spillway aeration is best determined through measurements and adjusted for temperature. Theoretical computations of selective withdrawal are sensitive to boundary conditions, such as the location of the outlet relative to the reservoir bottom, but withdrawal from the different layers can be estiwitnerawai from the different layers can be esti-mated from measured upstream and downstream temperatures and dissolved oxygen profiles. Downstream water quality under hydropower op-eration is predicted based on field measurements. eration is predicted based on field measurements. Improving selective withdrawal characteristics or diverting part of the flow over the spillway provides a cost-effective mitigation solution for small hydropower facilities (15 MW) because of the low capital investment. (Brunone-PTT) W91-09385

REAERATION EQUATIONS AND WASTE-LOAD ALLOCATIONS.

Mancini (John), Arlington, TX.

J. L. Mancini.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 117, No. 2, p 270-272, March/
April 1991. 1 fig, 1 tab, 4 ref.

Descriptors: \*Aeration, \*Biochemical oxygen demand, \*Mathematical equations, \*Waste load al-

location, \*Water pollution control, \*Water quality control, Dissolved oxygen, Environmental moni-toring, Estimating, Mathematical models, Water quality management.

Waste-load allocations for BOD (biochemical oxygen demand) and NH3 are often quite sensitive to the value of the reaeration coefficient. Inaccuracies in predicted dissolved oxygen deficits can influence waste-load allocations. The magnitude of influence waste-load allocations. The magnitude of these differences provides one indication of the reliability of dissolved oxygen modeling. Differences between observed and calculated reaeration coefficients can produce changes of about 30% in the calculated critical dissolved oxygen deficit. the calculated critical dissolved oxygen deficit. The uncertainty in dissolved oxygen concentrations, from the use of reaeration equations rather than measured reaeration coefficients, is probably on the order of tenths to one part per million. For environmentally sensitive areas, or waste load allocation decisions that require costly facilities, consideration should be given to measuring reaeration coefficients at or close to critical conditions. (Brunone-PTT)

IMPACT OF SURFACE WATER TREATMENT RULE ON GROUNDWATER. Pirnie (Malcolm), Inc., Newport News, VA. For primary bibliographic entry see Field 5F. W91-09403

CADMIUM AND ZINC BIOSORPTION BY CHLORELLA HOMOSPHAERA.
Centro de Tecnologia Mineral, Rio de Janeiro

For primary bibliographic entry see Field 5D. W91-09421

EVIDENCE FOR THE RESTORATION OF THE LAKE ERIE ECOSYSTEM.

State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.

J. C. Makarewicz, and P. Bertram.

Bioscience BISNAS, Vol. 41, No. 4, p 216-223,

April 1991. 6 fig, 1 tab, 62 ref.

Descriptors: \*Eutrophication, \*Lake Erie, \*Lake restoration, \*Phosphorus removal, \*Water quality trends, Algae, Anoxia, Biomass, Chlorophyll a, Crustaceans, Fish, Food chains, Lake ecology, Lakes, Nutrients, Oxygen, Phytoplankton, Population density, Stratification, Trophic level, Walleys, Waterfleas, Zooplankton.

Water quality, oxygen levels, and pelagic function appear to be improving in Lake Erie. The imple-mentation of a phosphorus reduction program to control the growth of phytoplankton has been accompanied by reductions to open-lake concentrations of total phosphorus, chlorophyll a, phytoplankton abundance and biomass, nuisance species plankton abundance and offinass, nuisance species abundance and biomass, and crustacean biomass in each of the basins of Lake Erie. These changes are consistent with expectations of long-term control by nutrients. Simultaneously, the recovery of the walleye fishery and the introduction of a new wantey insiery and the introduction of a new salmonine fishery have had a cascading effect on trophic structure. As top-level predators increased in abundance, forage fish abundance decreased, perhaps contributing to the establishment of the large predacious Bythotrephes cederstroemi by 1985 and allowing the larger Daphnia pulicaria to dominate the zooplankton community in 1984. Grazing pressure from Calanoida and Daphnia species appears to have caused a further decrease in algal abundance, an increase in filamentous algae during the summer, and a decrease in mean size of nonfilamentous algae. There are also indications that the persistent anoxic conditions in the bottom waters of the central basin have improved, suggesting cautious optimism on the ultimate objective of phosphorus reduction program: to restore oxic conditions to the bottom waters of the central basin during summer stratification. (Doria-PTT) W91-09452

RATIONAL NATURE MANAGEMENT IN THE ZONE OF IRRIGATION OF THE KURA-ARAKS LOWLANDS.

For primary bibliographic entry see Field 3F.

EFFECT OF THE OPERATION OF A PUMPED-STORAGE STATION ON THE THERMAL REGIME OF A NATURAL WATER

A. D. Girgidov, E. A. Loktionova, and V. V. Prvtkov.

Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 426-429, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 7-8, July 1990. 4 ref.

Descriptors: \*Dam effects, \*Environmental effects, \*Pumped storage, \*Reservoirs, \*Thermal pollution, Construction, Fisheries, Flow velocity, Hydraulic structures, Lakes, Mathematical models, Model studies, Shallow water, Temperature effects. The part of the state of the construction of the cons fects, Thermal stratification.

Lakes are often used as reservoirs for pumped-storage stations (PSSs). The consequent disturb-ance of the thermal regime in the region of water intake is an important problem for fisheries. Mathe-matical models were examined for the estimation of the size of the zone of influence of a PSS. The used a shallow-water approximation, first stage assuming the lake is a channel in which water velocity and temperature are constant over depth, and the water velocity is determined by the discharge schedule of the PSS. A more detailed description of lake phenomena permits the solution of the two-dimensional problem of a vertically ther-mal-stratified flow in the lake. Results of calculamai-stratuce I now in the lake. Results of Calcula-tions show good agreement with the solutions of two-dimensional test problems. This is the prereq-uisite for realization of the proposed two-dimen-sional model for solving the problem of longitudi-nal (with the water velocity in the lake) spread of heat with consideration of vertical thermal stratification and use of this model, in turn, as the test model for refining the parameters introduced into an estatiow-water model. Thus, the shallow-water approximation is recommended for long-range calculations and preliminary predictions at early design stages, whereas refining calculations could be carried out on the two-dimensional model at subsequent design stages. (Doria-PTT) W91-09455

EXPERIMENTAL EVALUATION OF FOOD CHAIN MANIPULATION AS A MEANS FOR PREVENTING ALGAL BLOOMS IN LAKES. Purdue Univ., Lafayette, IN. Water Resources Research Center W. R. DeMott.

W. K. DeMott.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-111518/
AS. Price codes: A03 in paper copy, A01 in microfiche. Technical Report No. 190, August 1990, 36p, 13 fig, 50 ref. USGS Contract No. 14-08-0001-G1561. USGS Project No. G1561-03.

Descriptors: \*Algae, \*Biological control, \*Eutrophication, \*Food chains, \*Water quality management, Algal blooms, Crustaceans, Fish ecology, Invertebrates, Lakes, Nutrients, Phosphoru Water quality, Zooplankton.

This study investigated means of manipulating lake food chains to enhance grazing by zooplankton and thereby to decrease algal biomass and to improve water clarity. Experiments were conducted at two levels. A relatively deep, stratified lake was monitored for two year prior and one year follow-ing the removal of fish by treatment with rotenone and we manipulated zooplankton, fish, and nutri-ents were manipulated in two series of experiments in 7000 liter mesocosms. Fish removal resulted in a shift in the zooplankton community to larger species, a substantial improvement in water clarity, and a decline in algal biomass. Mesocosm experiments showed that zooplankton communities dominated by moderate-sized native zooplankton or by introduced Daphnia pulicaria were equally effective in preventing algal biomass under both ambient and highly enriched nutrient levels when fish were absent. Introduced D. pulicaria out competed native zooplankton, suggesting that the asso-

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ciation of large Daphnia with low algal biomass is cuation of large Daphnia with low algal biomass is due to competition, rather than an inability of smaller grazers to prevent algal blooms. The tendency for zooplankton to remain in deep water, especially when fish are present, probably accounts for the observation that zooplankton are more effective in preventing algal blooms in shallow lakes than in deep lakes. (Wright-IN WRRC) W91-09469

METAL SPECIATION AND IMMOBILIZA-TION REACTIONS AFFECTING THE TRUE EFFICIENCY OF ARTIFICIAL WETLANDS TO TREAT ACID MINE DRAINAGE, Kentucky Water Resources Research Inst., Lex-

For primary bibliographic entry see Field 5B. W91-09504

INTEGRATED GIS/HYDROLOGIC MODEL FOR PHOSPHATE MINING RECLAMATION

University of South Florida, Tampa. Dept. of Civil

Engineering and Mechanics.
M. A. Ross, C. E. Fielland, and P. D. Tara.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland. 1990. p 31-39. 2 fig, 2 tab, 5 ref.

Descriptors: \*Florida, \*Geographic information systems, \*Hydrologic models, \*Land reclamation, \*Model studies, \*Water pollution prevention, Computer models, Computer programs, Data requirements, Mine wastes, Phosphates, Reclamation design, Technology transfer, Water resources.

The use of Geographic Information Systems (GIS) for spatial data handling in hydrologic modeling is an emerging technology that may greatly enhance water resources permitting analysis and design. A computer model has been developed for the State of Florida and is scheduled to be released for regulatory use in early 1991. The model integrates a commercial GIS, Tydac SPANS, public domain surface and groundwater hydrologic model, in a user friendly, menu-driven system developed at the University of South Florida. The objective of the research was to develop a microcomputer-based University of South Floridae. Ine objective of the research was to develop a microcomputer-based model for the mining industry to evaluate and assist in reclamation design of phosphate mine sites. The expected user community consists of State and local regulatory agencies, mining companies, and private consulting groups. The GIS serves as the spatial/analytical component, performing the time consuming Geography and provide component, performing the time consuming Geography and the site of the constraints of the constrain forming the time consuming Geo-referencing and spatial overlays (GIS modeling) to develop input data as well as providing the interface between the surface water and groundwater codes written with disparate spatial descriptions. Interactive menu disparate spatial descriptions. Interactive menu driven data file builders, developed as part of this interface, serve as the overall model drivers and allow selection of various optional temporal and other default data, for example, continuous and even design storms. Output includes complete hydrologic characteristics for a watershed or mine site (e.g., hydrographs, water table elevations) and GIS analyzed output (e.g., locations for wetlands sites). (See also W91-09570) (Author's abstract) W91-09574

CASE STUDY FOR THREE-DIMENSIONAL NUMERICAL GROUNDWATER FLOW MOD-

Weston (Roy F.), Inc., West Chester, PA. For primary bibliographic entry see Field 2F. W91-09581

VERIFICATION OF WATER QUALITY MODEL CODES: NCASI EXPERIENCE WITH THE QUAL2E AND WASP4 MODELS.

National Council of the Paper Industry for Air and Stream Improvement, Inc., Medford, MA. For primary bibliographic entry see Field 7C. W91-09597

STORMWATER MANAGEMENT MODEL VERSION 4.0 (SWMM 4.0)-A USER EXPERIENCE WITH A NEW VERSION OF A STAND-ARD HYDROLOGIC MODEL

Dames and Moore, Tampa, FL. For primary bibliographic entry see Field 7C. W91-09598

WATER QUALITY MODELING OF A CHAIN OF LAKES IN A RAPIDLY-DEVELOPING SUBURBAN AREA USING THE WERM

Montgomery (James M.) Consulting Engineers, Inc., Wayzata, MN.
D. R. Felstul.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 385-392. 1 fig. 4 tab, 10 ref.

Descriptors: \*Computer models, \*Eutrophication, \*Model studies, \*Spreadsheets, \*Water pollution control, \*Water quality, Computer programs, Lakes, Land use, Nonstructural alternatives, Nutrient concentrations, Phosphorus, Phosphorus re-moval, Runoff volume, Simulation, Technology transfer, Watersheds.

A spreadsheet-based computer model was used to A spreadsneet-oased computer model was used to simulate water quality in a chain of three important recreational lakes in a rapidly-developing water-shed located just south of the Minneapolis-St. Paul suburban area in Minnesota. The Prior-Spring Lakes Watershed consists of over 100 subwa-tersheds, including numerous ponds and wetland areas. Lakes, streams, and storm sewers were monitored to determine runoff volumes and nutrient concentrations for various land uses within the subwatersheds, including both rural and urban uses. The information was incorporated into the Watershed Eutrophication Reduction and Manage-ment (WERM) computer model which provided the outflowing phosphorus mass and water volume for each subwatershed. Once problem areas were identified, the same model was used to evaluate the effect of structural and nonstructural alternatives. The alternatives were modeled for both present and future land use since there is concern that development will cause poor water quality conditions in Lower Prior Lake similar to the current tions in Lower Prior Lake similar to the current eutrophic conditions existing in two upstream lakes. The WERM model appears to be an easily-used, yet adaptable model that gives acceptable results in a variety of situations, especially with high phosphorus loadings or in chains of lakes where other models may have problems. (See also W91-09570) (Author's abstract) W91-09610

MATHEMATICAL SUBMODELS IN WATER QUALITY SYSTEMS.

For primary bibliographic entry see Field 7C. W91-09611

ADSORPTION AND ION EXCHANGE.

Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry. For primary bibliographic entry see Field 7C. W91-09614

HEAT EXCHANGE.

California Univ., Davis. Dept. of Civil Engineer-For primary bibliographic entry see Field 7C. W91-09615

GROUND WATER ISSUES AND SOLUTIONS IN THE POTOMAC RIVER BASIN/CHESA-PEAKE BAY REGION.

For primary bibliographic entry see Field 2F. W91-09628

REDUCTION OF NITRATE LOADINGS TO GROUNDWATER.

Maryland Univ., College Park. Dept. of Agricultural Engineering.
A. Shirmohammadi, W. L. Megette, and L. L.

Shochtaker.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region.

National Water Well Association, Dublin, Ohio. 1989. p 261-270. 3 fig, 2 tab, 21 ref.

Descriptors: \*Agricultural practices, \*Groundwater, \*Groundwater pollution, \*Nitrates, \*Nonpoint pollution sources, \*Water pollution control, Barley, CREAMS model, Farm wastes, Maryland, Turf grasses, Watershed studies,

Nonpoint source pollution of groundwater systems have become a concern in recent years. Researchers and action agencies are investigating the source and processes of the contamination. Agricultural best management practices (BMPs) traditionally developed for reduction of nonpoint source pollu-tion of surface water resources are being investigated for their impact on groundwater quality. This study used the CREAMS model to simulate the long term effects of 7 different BMPs on nitrate loadings to the groundwater system. Two representative watersheds (5.8 and 8.9 hectares in area) were selected in the Coastal Plain physiographic region of Maryland. Soils in these watersheds belong to the Matapeake silt loam series with moderate intake capacity. Results indicated that BMPs erate intake capacity. Results indicated that BMPs with winter cover (barley) reduced the nitrate leachate to the groundwater system. It was also found that turfgrass reduces surface losses of water and pollutants but increases leaching losses of water and nitrate significantly. All of the BMPs tested in this study resulted in nitrate concentrations exceeding 10 parts per million, the EPA health standard for drinking water. (See also W91-09628) (Author's abstract) 09628) (Author's abstract)

COVER CROPS: A PARAGON FOR NITRO-GEN MANAGEMENT.

Maryland Univ., Queenstown. Wye Research and Education Center.

R. B. Brinsfield, and K. W. Staver.

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p. 271-285. 7 fig, 3 tab, 33 ref. USDA Low-Input Sustainable Agriculture Program Contract No. 88-COOP-1 3524 and USDA Northeast Regional Pesticide Impact Assessment Program sub-contract TPSU-UM-3361-457.

Descriptors: \*Agricultural practices, \*Cover crops, \*Groundwater recharge, \*Nitrates, \*Path of pollutants, \*Water pollution management, Groundwater, Nitrogen cycle, Nutrient removal, Nutrient transport, Rye, Solute transport.

Nitrate leaching during late fall and early winter groundwater recharge is the major pathway for nitrogen loss from the root zone for the coastal groundwater recharge is the major pathway for nitrogen loss from the root zone for the coastal plain soils in the Chesapeake Bay region. Cereal grain cover crops planted in the fall following commarvest offer an opportunity to immobilize residual root zone nitrogen, thus reducing the risk of movement of nitrate to groundwater. In this study, rye planted on September 15 following harvest of conventionally tilled corn assimilated approximately 130 kg/ha of total nitrogen and produced 3900 kg/ha of biomass within 85 days after emergence. A 30 day delay in planting resulted in a fivefold decrease in biomass production and a fourfold decrease in biomass production and a fourfold decrease in nitrogen uptake. Compared to other cereal grains, including wheat, oats, and barley, rye appears to be the most effective in removing residual root zone nitrogen. Unfortunately, if managed improperly cereal grain cover crops may reduce subsequent corn yields. However, even with the severe drought of 1988, corn yields from the no-till cover crop plots fertilized at recommended rates were similar to those observed in the no-till areas without a cover crop. Using a conservative estimate for nitrogen uptake of 20 kg/ha a rye cover crop planted following grain harvest in the major corn producing areas of Maryland's Eastern Shore could immobilize approximately the major corn producing areas of Maryland's Eastern Shore could immobilize approximately 794,000 kg of soluble root zone nitrogen, therefore making it unavailable for leaching to groundwater. (See also W91-09628) (Author's abstract) W91-09643

REGIONAL COMPARISONS OF BMP EFFEC-TIVENESS ON GROUND AND SURFACE WATER LOADINGS.

Maryland Univ., College Park. Dept. of Agricul-

### Water Quality Control—Group 5G

tural Engineering.
A. Shirmohammadi, and L. L. Shoemaker.
IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region.
National Water Well Association, Dublin, Ohio.
1989. p 437-455. 15 fig, 2 tab, 23 ref.

Descriptors: \*Agricultural practices, \*Best management practices, \*CREAMS model, \*Computer models, \*Model studies, \*Nonpoint pollution sources, \*Water pollution control, Agricultural runoff, Nitrates, Nitrogen, Nutrients, Phosphorus, Surface-groundwater relations.

Agricultural nonpoint source pollution plays a major role when considering the water quality assessment for any region. The CREAMS (Chemical, Runoff, Erosion from Agricultural Management Systems) model was used to simulate the impact of different agricultural BMPs (Best Management Practices) on groundwater and surface water quality in three distinct physiographic rewater quality in three distinct physiographic re-gions found in the Susquehanna River watershed, including Piedmont (field A), Appalachian (field E), and Blue Ridge (field C). Soils and geologic characteristics of each region were used in the simulation runs. Results indicated that the nutrient management plan (NMP) plays a major role in reducing surface and groundwater loadings of N and P. Although different practices were identified as being best or worst case scenarios with respect to surface and groundwater loadings, respectively, closer examination of data revealed no-till (NT) closer examination of data revealed no-till (N1) with NMP as being an optimum BMP. Data also indicated that the geologic characteristics of the Appalachian region (shallow pan-bedrock) resulted in higher runoff, soil, N, and P losses in surface processes than in the other two regions. (See also W91-09628) (Author's abstract) W91-09651

NEW APPROACHES FOR THE GENERATION OF GROUNDWATER QUALITY STANDARDS THE USE OF CONSENSUS TECHNIQUES IN REVISING VIRGINIA'S GROUNDWATER STANDARD.

Virginia Univ., Charlottesville. Div. of Urban and

Environmental Planning.
D. D. Annandale, R. C. Collins, A. B. Dotson, and

D. D. Annandale, R. C. Collins, A. B. Dotson, and C. L. Lancaster. IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 481-494. 11 ref.

Descriptors: \*Environmental policy, \*Groundwater quality, \*Legal aspects, \*Public policy, \*Virginia, \*Water quality standards, Administrative agencies, Administrative regulations, Decision making, Litigation, Public participation, Regulations.

One of the responses to the perceived problems of contemporary public management is a growing interest in new methods of resolving public disputes. In the area of environmental policy, where the burgeoning of new legislation in the 1970s has led to significant litigative conflict, consensus (or 'non-adversarial') techniques have been tested in a range of situations from disagreement over the siting of major projects, to the writing or revising of government agency regulations. Despite a growing literature on alternative means of dispute resolution (ADR) and negotiated rulemaking, very little assessment work has been produced, particularly in the relation to the development of water quality standards. A random survey of states which use a narrative (or written) standard for groundwater protection shows that few have uti-lized structured consensus-based techniques in de-veloping narrative standards. An analysis of the Virginia narrative standard (and the development Virginia narrative standard (and the development process) indicates the pros and cons of using consensus decision making methods to tackle broadly defined problems which contain issues of technical detail. Although the decision making group chose not to consider some detailed technical issues, the techniques used in the standard's development offer a positive example of how to increase public involvement at an early stage, and decrease the chances of possible future litigative conflicts. (See also W91-09628) (Author's abstract)

QUANTITATIVE TECHNIQUES APPLICABLE TO PROTECTION OF WATER SUPPLY WELLS IN THE CHESAPEAKE BAY AREA. Geraghty and Miller, Inc., Reston, VA. Modeling

Geragany
Group.

C. F. McLane, D. R. Buss, and R. A. Mace.
IN: Ground Water Issues and Solutions in the
Potomac River Basin/Chesapeake Bay Region.
National Water Well Association, Dublin, Ohio.
1989. p 495-516. 5 fig, 2 tab, 15 ref.

Descriptors: \*Administrative regulations, \*Chesa-peake Bay, \*Computer models, \*Groundwater management, \*Groundwater pollution, \*Water pollution control, \*Wellhead protection, Coastal aquifers, Groundwater basins, Water quality con-trol, Water resource management, Water supply, Wall fields

State and local regulatory agencies in the Chesa-peake Bay area may soon be faced with the task of delineating Wellhead Protection Areas (WHPAs) for public water supply wells and wellfields. Ap-plicability of the criteria and methods identified by the EPA Office of Ground Water Protection is dependent upon aquifer type, among other factors. As a guide for those preparing wellhead protection programs, example rating tables have been com-piled that evaluate WHPA delineation criteria and methods in the context of a coastal plain aquifer setting. Most of the WHPA delineation methods setting. Most of the WHA defineation methods involve computations based upon properties of the aquifer and the pumping rate of the well or well-field. Depending on program goals and available data, computations can range from a simple draw-down calculation using the Theis equation to complex numerical flow and transport models. A varieplex numerical flow and transport models. A varie ty of public domain software useful for WHPA delineation is available at low to moderate cost. Computer techniques will play a significant role in supporting WHPA delineation studies. (See also W91-09628) (Author's abstract)

STRATEGIES FOR ENVIRONMENTAL AS-SESSMENTS OF PROPERTY TRANSACTIONS. Geraghty and Miller, Inc., Annapolis, MD. J. P. Sgambat, and J. R. Mildenberger. IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 517-522.

Descriptors: \*Environmental impact statement, \*Legal aspects, \*Property value, \*Real estate transactions, \*Real property, \*Site remediation, \*Water pollution control, Economic aspects, Groundwater pollution, Investment, Monitoring wells, Rehabilitation, Soil contamination.

Conducting environmental assessments of property transactions in the Chesapeake Bay region in becoming an increasingly common and important activity. The approach and scope of these assessments are not standardized and are still evolving. Given realistic objectives and an understanding of the limitations involved, the technologies for investigation and data analysis do exist. Realistic objectives for site assessments are to identify gross or tigation and data analysis do exist. Realistic objectives for site assessments are to identify gross or high risk contamination, limit liability under CERCLA, adjust the cost of the property downward to reflect possible future cleanup activities, and comply with state property transfer laws where they exist. Limitations include the impossibility of providing a warranty that a site is 'clean', the lack of groundwater quality standards for many compounds, localized sources that may be missed, generation of 'smoking gun' data, and gened, generation of 'smoking gun' data, and ge missed, generation of 'smoking gun' data, and gen-eral time and budget constraints. Investigative techniques may include a review of site history (including title search, aerial photographs, fire in-surance maps, agency records, etc.), a review of site maps, a physical inspection, interviews with people familiar with the site, soil gas surveys, geophysical investigations, soil borings, and the installation and sampling of monitoring wells. Al-though risks can be substantially reduced by these studies significant uncertainties usually exist in studies, significant uncertainties usually exist in cases where some contamination is evident and the need for remediation in the future is possible. (See also W91-09628) (Tappert-PTT)

GROUNDWATER PROTECTION AND THE ROLE OF EDUCATION - AN APPRAISAL.

Virginia Polytechnic Inst. and State Univ., Blacks-

IN: Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 523-525.

Descriptors: \*Education, \*Groundwater pollution, \*Legal aspects, \*Legislation, \*Public relations, \*Water pollution control, Interagency cooperation, Local governments, Public participation, Public policy, State jurisdiction, Virginia.

The protection of groundwater resources has become a priority at the federal and state levels of government. In Virginia, the state has proceeded with implementation of the Safe Drinking Water Act, National Pollutant Discharge Elimination System, and new landfill regulations. The involve-ment of important local officials and individual ment of important local officials and individual land managers is critical to the success of a groundwater protection program. The Ground-water Protection Steering Committee put a high priority on federal, state and local input into edu-cational programs on groundwater quality protec-tion. Unlike many past issues, all agencies joined together for comprehensive coverage of an issue in which overall groundwater protection became the primary issue rather than individual agency pro-grams implemented on a piecemeal basis. Eight regional seminars were given which included the participation of local officials and ordinary citiparticipation of local officials and ordinary citi-zens. Many local meetings have been organized as a followup to the regional seminars. Many commu-nities have passed land use ordinances directed at groundwater protection goals. Research efforts and interagency cooperation are being handled in an integrative, comprehensive approach as part of the educational effort. The Steering Committee has helped bring groundwater protection concerns to the entire state, and in particular to local governmental officials and individual land managers who will be responsible for implementation of the protection strategy. (See also W91-09628) (Tappert-PTT W91-09656

DISTRIBUTION OF SIX HEAVY METALS IN CONTAMINATED CLAY SOILS BEFORE AND AFTER EXTRACTIVE CLEANING.

Technische Hogeschool Eindhoven (Netherlands). Dept. of Chemical Technology. B. J. W. Tuin, and M. Tels.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 10, p 935-948, 1990. 9 fig, 2 tab, 26 ref.

Descriptors: \*Clay soils, \*Cleanup operations, \*Heavy metals, \*Separation techniques, \*Site remediation, \*Soil contamination, Cadmium, Chromium, Copper, EDTA, Hydrochloric acid, Lead,

Many old industrial areas and waste disposal sites are contaminated to such an extent that action is required to prevent further environmental pollution. Extractive cleaning methods have been shown to be the most promising remedial techniques for clay soils contaminated with heavy metals. The soil distribution of Cd, Cr, Cu, Ni, Pb, and Zn was determined before and after extractive cleaning. A sequential procedure using 0.1N HCl or 0.1M EDTA showed that the efficiency of metal extraction from soil fractions decreases in the order: carbonate > Fe/Mn-oxides > organic/ sulfidic > residual, with 50% of the experiments indicating less than 33% efficiency from the residual fraction. Removal of these intractable pollutants requires more drastic methods which will probably destroy other soil components. (D'Agostino-PTT)

REMOVING HEAVY METALS FROM CONTAMINATED CLAY SOILS BY EXTRACTION WITH HYDROCHLORIC ACID, EDTA OR HY-POCHLORITE SOLUTIONS.

Technische Univ. Eindhoven (Netherlands). Dept. of Electrical Engineering.

### Group 5G-Water Quality Control

B. J. W. Tuin, and M. Teis. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 11, p 1039-1052, 1990. 3 fig, 7 tab, 37 ref

Descriptors: \*Clay soils, \*Cleanup operations, \*Heavy metals, \*Remediation, \*Separation techniques, \*Soil contamination, Cadmium, Chromium, Copper, EDTA, Hydrochloric acid, Hydrogen ion concentration, Lead, Nickel, Sodium hypochlorite, Soil treatment, The Netherlands, Zinc, pH.

Extraction methods are currently being studied as potential procedures for the cleaning of soils contaminated by heavy metals. The removal efficiencies of six heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) from clay soils were measured in batchwise extractions using varying conditions and extractants. 80-90% of Cd, Cu, Pb, and Zn and 45-80% of Ni were extracted with HCl using either repeated cycles with 0.1N or a single extraction with 2.0N HCl. Problematically, the concentrations necessary to decontaminate soils to the maximum levels allowed by the Dutch Soil Clean-up Interim Act (A-level) will cause severe damage to the original soil structure. EDTA, at pH < 4, extracted only Cd and Pb at levels comparable to the HCl and EDTA, was efficiently extracted (70-85%) by treatment with hot 0.46M sodium hypochlorite at pH 8.5. (D'Agostino-PTT)

SOIL CLEAN UP IN-SITU AERATION, II, EF-FECTS OF IMPERMEABLE CAPS, SOIL PER-MEABILITY, AND EVAPORATIVE COOLING. Vanderbil Univ., Nashville, TN. Dept. of Chemis-

Yannon, D. J. Wilson, A. N. Clarke, R. D. Mutch, and J. H. Clarke. Separation Science and Technology SSTEDS, Vol. 24, No. 11, p 831-862, September 1989, 17 fig. 2 rab. 13 ref.

Descriptors: \*Cleanup operations, \*In situ treatment, \*Priority pollutants, \*Site remediation, \*Soil contamination, \*Vapor stripping, \*Volatile organic compounds, Aeration, Cooling, Evaporation, Flow around objects, Flow regulators, Impermeable caps.

Over 1200 hazardous waste sites are currently included on the EPA's National Priority List, and the estimated clean-up costs average over \$10 million per site. The relatively light environmental impact and low cost of in-situ methods, therefore, make them quite attractive. Vapor stripping has emerged as one of the more promising methods for the clean up of soils contaminated by volatile compounds. As a modification of existing procedures, the effect of placing gas-tight circular caps of various radii over the calculated soil gas velocity field in the zone of influence around the vent pipe was examined. Such caps reduce the excessive flow of gas in the vicinity of the cylinder axis of the vent pipe and increase gas velocities near the periphery. Use of these impermeable circular caps to direct soil gas flow improves the efficiency of in-situ vapor stripping by 50%. Flow perturbations around buried obstacles are not likely to seriously interfere with the stripping process. Also, low soil permeabilities can be compensated for by increasing the radius of the well gravel packing. Under normal operating circumstances, evaporative cooling was insignificant. (See W91-09684 thru W91-09686) (D'Agostino-PTT)

SOIL CLEAN UP BY IN-SITU SURFACTANT FLUSHING, I. MATHEMATICAL MODELING. Vanderbilt Univ., Nashville, TN. Dept. of Chemistry

D. J. Wilson.

Separation Science and Technology SSTEDS, Vol. 24, No. 9/10, p 863-892, July/August 1989. 13 fig, 3 tab, 24 ref. Supported by AWARE, Inc. and the University of Tennessee Water Resources Research Center.

Descriptors: \*Aquifers, \*Cleanup operations, \*Decontamination, \*Groundwater pollution, \*In situ

treatment, \*Mathematical models, \*Soil contamination, \*Surfactants, Design criteria, Flushing, Groundwater reservoirs, Hydrophobic compounds, Organic compounds, Separation techniques, Site remediation.

Organic chemical contamination of groundwaters is a major pollution problem in the United States. In-situ approaches, which manage contaminated material in place, are becoming increasingly attractive due to their effectiveness and low cost. Previous studies showed that surfactant flushing may be a viable method for the clean up of soils contaminated with nonvolatile organic compounds due to the ability of surfactants to solubilize water-insoluble compounds, as well as, the ease of leachate treatment and surfactant cycling. A mathematical model is developed which simulates field-scale insitu flushing of hydrophobic organic compounds in an aquifer by means of an injection and recovery well, either in an unconfined two-dimensional domain or surrounded by a slurry wall barrier. A similar model is constructed for the flushing of contaminated soils in laboratory columns. These models, in conjunction with solubility, extraction, and leaching studies, may prove useful to design engineers when assessing this technique for specific soil decontamination projects. (See W91-09683 thru W91-09686) (D'Agostino-PTT)

### SOIL CLEAN UP BY IN-SITU SURFACTANT FLUSHING, II. THEORY OF MICELLAR SO-LUBILIZATION,

Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

H. J. Wayt, and D. J. Wilson.

Separation Science and Technology SSTEDS, Vol. 24, No. 12/13, p 905-937, October 1989. 11 fig, 4 tab, 20 ref.

Descriptors: \*Cleanup operations, \*Decontamination, \*Flushing, \*Groundwater pollution, \*In situ treatment, \*Mathematical models, \*Site remediation, \*Soil contamination, \*Surfactants, Amphipathic compounds, Aquifers, Cleaning, Design criteria, Electrochemistry, Groundwater reservoirs, Hydrophobic compounds, Organic compounds, Separation techniques, Solubility.

In-situ decontamination techniques are attractive methods for soil clean up due to their low environmental impact and low cost. Also, they often result in the destruction or removal of toxic compounds, rather than merely their containment. In the first paper of this series, a mathematical model was presented which described the process of surfactant flushing. In this companion paper, a mathematical theory of micellar solubilization, which plays a crucial role in the surfactant flushing technique, is presented. Models for describing the solubilization of contaminants in micelles of both ionic and nonionic surfactants are constructed. Contaminants which are purely hydrophobic as well as amphipathic compounds are described by means of a Debeye-Huckel approach. The linear dependency of the solubility of the contaminant on surfactant concentration, above a critical point, is in agreement with actual experimental results and the theory predicts solubility enhancement by approximately two orders of magnitude at surfactant concentrations of < or = 0.1M. The models can be easily run on readily available microcomputers. (See W91-09683 thru W91-09686) (D'Agostino-PTT)

SOIL CLEAN UP BY IN-SITU AERATION, III. PASSIVE VENT WELLS, RECONTAMINATION, AND REMOVAL OF UNDERLYING NONAQUEOUS PHASE LIQUID. Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

try.
D. J. Wilson, A. N. Clarke, and R. D. Mutch Jr.
Separation Science and Technology SSTEDS,
Vol. 24, No. 12/13, p 939-979, October 1989, 16

Descriptors: \*Aeration, \*Cleanup operations, \*In situ treatment, \*Model studies, \*Site remediation,

\*Soil contamination, \*Volatile organic compounds, Diffusion, Gas flow, Liquid wastes, Non-aqueous liquid wastes, Passive vent wells, Vadose zone, Vapor stripping.

Advantages obtained from the use of in-situ aeration for soil decontamination include low cost, relatively low environmental impact, and effectiveness. The benefits of using passive vent wells in the expor stripping process were examined, and the extent of recontamination by diffusion of vaporized substances from underlying nonaqueous phase liquids (NAPL) beneath the vadose zone was investigated. The modeling of soil vapor stripping was done by partitioning the soil to be aerated into a number of small volume elements and carrying out a mass balance on each. It was assumed that Henry's law adequately described the partitioning of the volatile contaminant between the moving vapor phase and the stationary phase (either interstitial liquid or adsorption sites on solid particles). Use of more elaborate isotherms is quite possible, but the data to support these are not yet available. The set of differential equations for the mass balance on each volume element was then integrated forward in time numerically. Results indicate NAPL removal rates of 2 to 5 kg/day per well can be expected under certain operating conditions, however, this technique is predictably useless for removing dense NAPL due to their extremely slow diffusion rates through water. Also, contrary to expectation, passive vent wells do not increase soil clean up rates by this method. (See W91-09683 thru W91-09685) (D'Agostino-PTT) W91-09686

CURRENT ISSUES IN ENVIRONMENTAL MANAGEMENT: A CASE STUDY OF SOUTH-ERN CALIFORNIA'S MARINE MONITORING SYSTEM

Conservation Foundation, Washington, DC. W. M. Eichbaum, and B. B. Bernstein. Coastal Management CZMJBF, Vol. 18, No. 4, p 433-445, 1991. 1 fig, 9 ref.

Descriptors: \*California, \*Coastal zone management, \*Environmental monitoring, \*Environmental policy, \*Pollutant identification, Administrative regulations, Assessments, Decision making, Management planning, Monitoring, Water pollution sources, Water quality management.

A case study panel of the National Research Council's Committee on Systems Assessment of Marine Environmental Monitoring analyzed the monitoring system in the Southern California Bight. The goal of the assessment was to identify monitoring's contribution to decision-making and to recommend how effective monitoring programs could be designed. The committee viewed monitoring as part of a management system including public concerns, laws and regulations, and the decision-making infrastructure. In assessing this larger system, the panel found many monitoring programs in the bight, regulated and performed by a variety of public and private agencies. These programs had contributed to the understanding of impacts around point sources. However, larger-scale and cumulative impacts were not well monitored because of an emphasis on point-source impacts only. Additionally, it was found that management inflexibilities have led to inefficient use of monitoring resources; shortcomings derived more from the management structure of the monitoring system than from scientific or technical problems. Thus, nebulous management objectives, a permit-by-permit approach to regulation and monitoring, and lack of institutional coordination were identified as important constraints. In order to overcome these constraints and address issues that currently fall outside the monitoring system, the case study panel recommended four initiatives: perform bightwide assessments of environmental issues for planning and scoping purposes; clarify management information needs and monitoring objectives; design and implement a regional database management system that will make results of monitoring and oceanographic studies more widely available. (Fish-PTT)

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

USE OF ISOTOPE FRACTIONATION OF SUL-FATE-SULFUR AND SULFATE-OXYGEN TO ASSESS BACTERIAL DESULFURICATION IN

Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.). For primary bibliographic entry see Field 2F. W91-09717

METHODS FOR SELECTION AND HYDRO-LOGIC DESCRIPTION OF POTENTIAL LANDFILL SITES IN SOUTHEASTERN SAN DIEGO COUNTY, CALIFORNIA. Geological Survey, San Diego, CA. Water Re-sources Div.

For primary bibliographic entry see Field 5E. W91-09817

GROUNDWATER QUALITY AND PRELIMINARY ASSESSMENT OF THE POTENTIAL PARY ASSESSMENT OF THE PUTENTIAL FOR CONTAMINATION BENEATH AGRICUL-TURAL LANDS IN CENTRAL LONOKE COUNTY, ARKANSAS, Geological Survey, Little Rock, AR. Water Re-

sources Div.

For primary bibliographic entry see Field 5B. W91-09821

AGRICULTURAL CHEMICALS AND GROUNDWATER QUALITY.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.

For primary bibliographic entry see Field 5B. W91-09868

PUBLIC POLICY PERSPECTIVE ON GROUNDWATER QUALITY. Florida Univ., Gainesville. Dept. of Food and Re source Economics.

For primary bibliographic entry see Field 6B. W91-09869

KEY POLICY CHOICES IN GROUNDWATER QUALITY MANAGEMENT. Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics. S. Batie, and P. L. Diebel.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 194-197, 1990. 19 ref. USGS award members 14-08-001-1303 and 14-08-0001-

Descriptors: \*Groundwater protection, \*Groundwater quality, \*Policy making, \*Public policy, \*Water pollution control, \*Water quality management, Decision making, Environmental Protection Agency, Groundwater management, Resources development, Resources management, State jurisdiction, Uncertainty.

The fundamental policy choice of 'who has the right to do what to whom' is a pivotal issue of governance. Over the last few decades, the answer to that question has become more restrictive to those who own and use natural resources as inputs the whole of the process of the pr into production processes. Increasingly, the beneficiaries of new policy initiatives are those who desire higher protection of groundwater quality. With respect to groundwater management, policy design increasingly reflects such diverse interests as agriculturalists, industrialists, homeowners, local government officials and state officials. Policy design is becoming complex, in part because of this design is becoming complex, in part occase of this diversity and in part because scientific uncertainty hampers informed policy design. No 'umbrella' federal legislation exists for managing groundwater resources. EPA's role has been mainly an advisory one on groundwater issues. The difficulties and responsibilities of protecting groundwater thus remain with the states. For the near future, it is the remain with the states. For the hear future, it is that states that will address key policy choices with respect to groundwater quality management issues. (Author's abstract) W91-09870

COMMUNICATING WATER QUALITY RISK. Cornell Univ., Ithaca, NY. Dept. of Communica-

tion. C. W. Scherer. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 198-200, 1990. 17 ref.

Descriptors: \*Groundwater quality, \*Local governments, \*Public participation, \*Public policy, \*Risk assessment, \*Risk communication, \*Water quality, Behavior, Long-range planning, Policy making, Public relations, Social aspects.

Technology for detecting and understanding water quality problems and the impacts of activities on long-range groundwater quality has advanced considerably. In the past a technical solution was considered adequate but today we must consider a wide range of both technical and social factors in evaluating technical alternatives that are also acceptable activities. Bolicia developed and ceptable social solutions. Policies developed and implemented with limited local participation generally are resisted and become ineffective if public cooperation is necessary for effective implementation. The public, the experts and the policymakers all must understand and appreciate the different perspectives present in risk policymaking. The typical model used to involve the public in policy decisions is a strategy descried as the decide-announce-defend-approach. Much more acceptable to the public, but also more difficult to implement, is a strategy, that sale for feen flower of informatical transfer. is a strategy that calls for free flow of information within the community about the problem, policies and potential solutions. Communication about and potential solutions. Communication about complex issues will be more successful if the com-munication is substantial; if it takes advantage of existing interpersonal networks and mass media; if it pays particular attention to existing audience knowledge, interest and behaviors; and if it clearly targets messages to various segments of the audi-ence. (Feder-PTT) W91-09871

AGRICULTURAL BEST MANAGEMENT PRACTICES AND GROUNDWATER PROTECTION.

Ohio State Univ., Columbus, Dept. of Agronomy. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 201-206, 1990. 25 ref.

Descriptors: \*Agricultural practices, \*Best management practices, \*Groundwater pollution, \*Non-point pollution sources, \*Water pollution cources, Agricultural runoff, Agricultural wastes, Economic aspects, Groundwater management, Pesticides, Resource management.

Best management practices (BMPs) are methods, measures or practices designed to prevent or reduce pollution. They include structural and non-structural control as a small processor of the proce reduce pollution. They include structural and non-structural controls as well as operation and mainte-nance procedures. Agricultural pollution is regu-lated under several federal statutes; the states ad-minister nonpoint-source and groundwater pollu-tion abatement programs. The BMP concept was developed specifically to deal with nonpoint-source pollution problems. BMPs for groundwater protection must consider several factors, including conditions that permit significant movement of inconditions that permit significant movement of in-filtrating water to groundwater, solubility and soil affinity of the specific pollutant, pollutant loadings and the ability of the specific BMP to alter any of these conditions. Selection should include soil these conditions. Selection should include soin type, climate, pollutant characteristics and BMP impacts on hydrology, pollutant characteristics and pollutant loadings. The effectiveness of BMPs can be rated in terms of their impact on pollutant loads, acceptability by farmers, cost-effectiveness and ease of implementation and maintenance. Source controls are most effective. The BMP approach addresses nonpoint-source problems in a manner compatible with the traditional, voluntary manner compatible with the traditional, voluntary approach to resource management. This approach has failed to produce significant national reductions in nonpoint-source pollution. BMPs have not been accepted widely by the agricultural community, especially in the absence of cost-sharing or a clear economic advantage for the practice. (Feder-PTT) W91-09872

PROTECTING GROUNDWATER QUALITY BY MANAGING LOCAL LAND USE

### Water Quality Control—Group 5G

Wisconsin Univ.-Madison. Environmental Reources Center. D. A. Yanggen, and S. M. Born.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 207-210, 1990. 14 ref.

Descriptors: \*Groundwater protection, \*Groundwater quality, \*Land management, \*Land use, \*Local governments, \*Water policy, Governments dal interrelations, Groundwater Groundwater pollution, Public Water pollution prevention, Zoning.

The close relationship between land use and groundwater quality means that local government can play a significant role in protecting this re-source. Higher levels of government are often unable to consider unique local characteristics land use management because of their need to generalize across broad geographic areas. Local governments can attempt to fashion management decisions that reflect unique local characteristics. To be most effective, local protection programs generally should employ a mixture of regulatory and nonregulatory techniques. Nonregulatory approaches include public education and involvement, voluntary best management practices, land acquisition programs, facility siting procedures and capital facility and infrastructure planning, inspection and training programs, monitoring, emergency spill plans, community waste management and minimization programs and governmental coordi-nation efforts. (Feder-PTT)

LIABILITY ISSUES IN GROUNDWATER QUALITY PROTECTION.

For primary bibliographic entry see Field 6E. W91-09874

GROUNDWATER QUALITY ASSESSMENT THROUGH COOPERATIVE PRIVATE WELL TESTING: AN OHIO EXAMPLE, Heidelberg Coll., Tiffin, OH. Water Quality Lab. For primary bibliographic entry see Field 5A. W91-09879

FARMSTEAD ASSESSMENTS: A STRATEGY TO PREVENT GROUNDWATER POLLUTION. Wisconsin Univ.-Extension, Madison S. A. Jones, and G. W. Jackson. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 236-238, 1990. 7 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural runoff, \*Agricultural wastes, \*Farm wastes, \*Groundwater pollution, \*Nonpoint pollution sources, \*Water pollution control, Fertilizers, Festicides, Risk assessment, Well water, Wisconsin.

Farmstead pollution potential assessments are evolving in response to a need for clear, useful information on potential farmstead sources of groundwater contamination and for a method to ssess and prioritize action to reduce groundwater assess and prioritize action to reduce groundwater pollution potential. Staff members from Wisconsin and Minnesota Extension, Region V of the U. S. EPA and the Wisconsin Geological and Natural History Survey are developing and refining farmstead pollution potential assessment procedures. Worksheets explaining these procedures can assist farmers in identifying potential farmstead sources of groundwater contamination and in prioritizing management and structural changes to minimize the risk of groundwater contamination from identified sources. The farmstead assessment begins with a site evaluation. This includes evaluating how soil, a site evaluation. This includes evaluating now sort, geologic and hydrologic site conditions affect pollution potential and developing a diagram of all farm buildings and the location of farmstead activities in relation to the drinking water well. Once this basic information is organized, the farmer uses this basic information is organized, the farmer uses the farmstead assessment system series of 12 worksheets to organize information and rank pollution risks associated with each farmstead structure and activity. The result is a priority action list for minimizing groundwater contamination potential. (Feder-PTT)

### Group 5G-Water Quality Control

PRESCRIPTION PLANNING: AN APPROACH TO NONPOINT POLLUTION PROBLEMS.
South Dakota State Univ., Brookings. Dept. of

Plant Science.
C. G. Carlson, R. Dean, and G. Lemme.
Journal of Soil and Water Conservation JSWCA3,

Vol. 45, No. 2, p 239-241, 1990. 4 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Environmental policy, \*Groundwater quality, \*Management planning, \*Nonpoint pollution sources, \*Water pollution management, \*Water quality, Best management practices, Resources management, South Dakota.

Prescription planning is an intensive management process geared to minimize nonpoint agriculture pollution. The process has three steps: (1) Prioriti-zation and estimation of the value of the water zanon and estimator of the value of the water resources within the geographical area of concern; (2) Determination of the vulnerability of the valued water resources within the geographical area of concern; and (3) Making a management decision that integrates protection of water re-sources with the maintenance of agronomic prosources with the maintenance of agronomic productivity. This particular process was developed from experience over the last eight years with the Rural Clean Water Program (RCWP) in South Dakota. Each participating farmer was required to conduct a yearly farming program review with the Cooperative Extension Service and The Soil Conservation Service. During the growing season the farmer also was required to participate in weekly reviews with an agronomist. RCWP has shown that best management practices must revolve. that best management practices must revolve around a resource management plan developed to balance surface water and groundwater quality with agronomic productivity. Timely consultations to review and update the plan also are essential. (Feder-PTT) W91-09881

GIS-BASED APPROACH TO EVALUATING REGIONAL GROUNDWATER POLLUTION POTENTIAL WITH DRASTIC.

Geo Decisions, Inc., P.O. Box 1028, Lemont, Pennsylvania 16851.

For primary bibliographic entry see Field 7C. W91-09882

GEOGRAPHIC INFORMATION SYSTEM FOR GROUNDWATER PROTECTION PLANNING. Rhode Island Univ., Kingston. Dept. of Natural Resources Science.

For primary bibliographic entry see Field 7C. W91-09883

ENVIRONMENTAL REGULATION OF AGRI-CULTURE IN ARIZONA.

Arizona Dept. of Environmental Quality, Phoenix. B. E. Munson, and C. Russell.
Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 249-252, 1990. 2 ref.

Descriptors: \*Administrative regulations, \*Agricultural practices, \*Arizona, \*Environmental policy, \*Water pollution control, Environmental law, Feedlot runoff, Fertilizers, Nitrates, Pesticides, Regulations, Water quality.

The Environmental Quality Act of 1986 estab-lished two unique programs that focus on the influence of agriculture on water quality in Arizo-na. The Regulated Agricultural Activities Pro-gram, was established to regulate pollution from the use of nitrogen fertilizers and from concentrated animal feeding operations. The Pesticide Con-tamination Prevention Program was adapted from similar California legislation. It was established with two purposes: to identify pesticides that have contaminated, or have the potential to contaminate groundwater in Arizona and to regulate their use to prevent further contamination. The Regulated Agricultural Activities Program focuses on regu-lating activities that introduce nitrates into the environment while the Pesticide Contamination Prevention focuses on regulation of specific chemicals. The Arizona Department of Environmental Quality is the implementing agency for these two programs. (Feder-PTT)

W91-09884

AGRICULTURAL CHEMICALS IN GROUND-WATER: MONITORING AND MANAGEMENT IN CALIFORNIA.

California Univ., Los Angeles. School of Public

D. M. Mackay, and L. A. Smith. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 253-255, 1990. 14 ref.

Descriptors: \*Agricultural chemicals, \*California, Descriptors: "Agricultural chemicals, "Caulforma, "Groundwater pollution, "Monitoring, "Nitrates, "Nonpoint pollution sources, "Pesticides, "Water pollution control, "Water quality monitoring, Leaching, Public health, Water pollution prevention, Water quality standards.

Extensive monitoring efforts in California in recent years have detected a variety of pesticides and nitrates in many wells throughout the state. The contaminant concentrations are generally low and often below health criteria. However, thousands of wells in California exceed health criteria because of contamination from nitrates and a few pesticides. The majority of pesticides detected are compounds that have not been used in the state for 5 to 10 years. Earlier warnings of incipient problems are needed, such as those provided by soil coring and shallow groundwater monitoring wells. Cali-fornia is establishing areas within which the release of pesticides or nitrates will be managed. For pestiuse restrictions have not been considered cides, use restrictions have not been considered until the contaminant has been detected in ground-water. Screening approaches may help to identify pesticides or other compounds that nay not have been detected in groundwater yet but nonetheless are potential leachers. This information can be used in both the design of monitoring efforts and the establishment of preventative management practices. (Feder-PTT)

CLARKE COUNTY, VIRGINIA'S INNOVATIVE RESPONSE TO GROUNDWATER PROTEC-TION.

Clarke County, Berryville, Virginia 22611-0169. G. R. Lee, and T. J. Christoffel. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 257-259, 1990.

Descriptors: \*Groundwater pollution, \*Ground-water quality, \*Local governments, \*Management planning, \*Water pollution control, Clarke County, Education, Geographic information sys-tems, On-site wastewater treatment, Sinkholes, Underground storage tanks, Water quality standards.

In 1982, the Clarke County Planning Commission created a Water Supply Committee which led to the following county actions: adoption of a re-source conservation overlay zone to protect the County Sanitation Authority's public spring; sub-mission of the first Virginia application for federal sole-source aquifer designation; drafting of a pro-posed oil and gas exploration and extraction ordi-nance; and a contract with the USGS for a threeyear groundwater resources study. In February 1987, the Clarke County Plan was published. Six implementation strategies were recommended, the majority of which have been adopted: (1) on-site wastewater treatment system management; (2) a sinkhole ordinance; (3) well standards; (4) undersunknoice ordinance; (3) weil standards; (4) under-ground storage tank requirements; (5) community education; and (6) a geographic information system. This plan emphasizes direct local govern-ment land use policies designed to mitigate risks of groundwater contamination. The plan used exist-ing technical information to focus on prevention as the best strategy for natural resource protection. (Feder-PTT) W91-09887

INTEGRATED APPROACH TO WATER RE-SOURCES MANAGEMENT: THE CARROLL COUNTY, MARYLAND STORY. Bureau of Water Resource Management, Carroll County, Maryland, 225 N. Center Street, Westmin-ster, Maryland 21157.

For primary bibliographic entry see Field 6A.

W91-09888

COOPERATION AS A POLICY INITIATIVE IN

Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering. R. Peralta, and A. Peralta.

Journal of Soil and Water Conservation Vol. 45, No. 2, p 261-262, 1990. 11 ref.

Descriptors: \*Interagency cooperation, \*Public participation, \*Public policy, \*Utah, \*Water pollution control, Decision making, Education, Information exchange, Local governments, Nonpoint pollution sources, Performance

Giving cooperation the rank of a policy objective facilitates the achievement of stated water quality objectives. The keys to making mandates effective are the interagency, interorganizational and inter-personal relationships that exist and evolve over personal relationships that exist and evolve over time. Efforts to defuse potential conflicts should be an important part of public policy initiatives. The Utah Nonpoint-Source Coordinating Committee has used some innovative ideas to address three variables in working successfully together: the broadness of the base of participation; the level of trust; and the relative willingness of participants to share information with the other players. The committee coordinates training for agency personnel, decision-makers, and the general public; coordinates development of common reference materials by all involved agencies; provides evaluation criteria for cooperative, interagency county water quality programs; and recognizes (rewards) accomplishments of cooperative interagency efforts at the county level. (Feder-PTT) W01\_00880

SPECIAL PROTECTION AREAS: A NEW NON-POINT-SOURCE MANAGEMENT OPTION IN NEBRASKA.

Nebraska Dept. of Environmental Control, Lincoln. Ground Water Section. R. L. Ehrman, M. L. Link, and J. J. Gotfula. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 263-264, 1990. 7 ref.

Descriptors: \*Environmental policy, \*Groundwater pollution, \*Nebraska, \*Nonpoint pollution sortees, \*Special protection areas, \*Water pollution control, Funding, Interagency cooperation, Local governments, Monitoring, Public participation, Persents pariodicing. tion, Research priorities.

The 1986 Special Protection Area Program gave the Nebraska State Department of Environmental Control and the states 23 natural resources districts authority to implement measures to control nonauthority to implement measures to control non-point-source groundwater contamination. Any state agency or political subdivision of the state can submit evidence of groundwater contamina-tion to the department with a request for special protection area consideration. The department non to the department with a request for special protection area consideration. The department then evaluates and prioritizes the requests. The next step is a detailed study to determine the cause(s) of the groundwater contamination. This study must be completed within one year. The department may recommend special protection department may recommend special protection area designation for all or part of the study area. A public hearing is held to assess public and other agencies' reaction. Once the area is designated, responsibility shifts from the department to the local natural resources district(s). The district(s) has 180 days to develop an action plan to address the contamination. After the plan is formulated, a public hearing must be held to receive comments on the action plan. The district must also develop a on the action pian. The district must also develop a monitoring program to evaluate the effectiveness of the action pian. Experiences to date indicate the following: (I) the modest amount of funding to the state Environmental Control agencys may not be sufficient; (2) the one-year time constraint for detailed studies can restrict study activities severely; and (3) the funds available to the natural resource districts may not be sufficient. (Feder-PTT) W91-09890

### IMPLEMENTATION ISSUES IN SPECIAL GROUNDWATER QUALITY PROTECTION AREAS.

Nebraska Univ., Lincoln. Dept. of Agricultural Economics.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 264-265, 1990.

Descriptors: \*Enforcement, \*Groundwater pollution, \*Nebraska, \*Nonpoint pollution sources, \*Special protection areas, \*Water pollution control, Administrative agencies, Agricultural chemicals, Environmental policy, Funding, Groundwaters er quality, Legal aspects.

In Nebraska, fertilizer and pesticide use may be regulated by local natural resource districts within state-designated 'special groundwater quality pro-tection areas.' The authority to regulate fertilizer tection areas.' The authority to regulate fertilizer applications is essential in nonpoint pollution control. Program limitations include inadequate state review of local special protection area management plans; inadequate funding; and misinterpretation of statutes. The Nebraska Department of Environmental Control needs broader oversight authority over district management plan implementation and modification to accomplish the program's objectives. At current funding levels, many areas of rural Nebraska with significant nitrate contamination problems will not be studied by the department for special protection area designation for ment for special protection area designation for several years. A potential source of program reve-nue is a surcharge on pesticides and fertilizers. The regulatory and university communities incorrectly assume that special protection areas may be desig-nated only where contamination is at or near drinking water levels and only where contamina-tion currently is occurring and can be documented conclusively. Each assumption is legally incorrect and precludes administering the program to pre-vent contamination. (Feder-PTT)

GROUNDWATER QUALITY MANAGEMENT IN NEBRASKA'S CENTRAL PLATTE VALLEY. Nebraska Univ., Clay Center. R. B. Ferguson, and M. Moravek. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 265-266, 1990. 6 ref.

Descriptors: \*Groundwater pollution, \*Nebraska, \*Nitrates, \*Nonpoint pollution sources, \*Platte River Basin, \*Water pollution control, Agricultural practices, Crop production, Environmental policy, Farm management, Groundwater quality, Well water.

The primary crop grown in Nebraska's central Platte Valley is corn. Production practices over the years have resulted in rising nitrate concentration in groundwater in much of the valley. By the early 1990's, nitrate-nitrogen concentrations in many wells had risen to 15 ppm or more. In 1987, the Central Platte Natural Resources District implemented a three-phase groundwater management plan for the natural fixers. plan for the entire district. Areas of the district that are regulated according to the phase-1 level of control have an average groundwater nitrate-nitro-gen concentration between 0 ppm and 12.5 ppm. Within these area, fall and winter application nitro-gen fertilizer is banned on sandy soils. Phase 2 areas have an average groundwater nitrate-nitro-gen concentration between 12.6 ppm and 20 ppm. Fertilizer applications are restricted, annual soil samples and annual reports are required and operators must receive training in irrigation and nitrogen management. Phase 3 areas have an average nitrate-nitrogen concentration greater than 20 ppm. These areas must conform to the Phase 1 and 2 standards and also nitrogen fertilizer application is banned until after March 1 and split application of nitrogen or the use of an approved nitrification inhibitor is requires. (Feder-PTT) W91-09892

# RURAL RESIDENTIAL DEVELOPMENT: EVOLUTION OF A SEPTIC SYSTEM REGULATORY PROGRAM.

New Mexico Health and Environment Dept., Santa Fe. Environmental Improvement Div.

R. J. Perkins, and P. Hanson. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 266-268, 1990. 2 ref.

Descriptors: \*Groundwater pollution, \*Land development, \*New Mexico, \*On-site wastewater treatment, \*Regulations, \*Septic tanks, \*Water pollution control, Drinking water, Environmental protection, Public health, Public participation, Rural areas.

The initial groundwater quality concerns of New Mexico's regulatory program concentrated on public health protection from bacterial contaminapublic health protection from bacterial contamina-tion of drinking water supplies. Minimum lot sizes were established for consumer protection pur-poses. Lot sizes were typically reduced through variances. The minimum lot size for a typical family residence has been changed from one half an acre to one third acre where a community water supply was available. New Mexico has elimi-nated the distinction between requirements of lots provided with community water and lots with on-site wells. The State has also become more sensitive to the need for greater public involvement in environmental protection. (Feder-PTT) W91-09893

### LOCAL GOVERNMENTS COOPERATING TO PROTECT GROUNDWATER,

sota State Planning Agency, St. Paul. M. D. Lundberg.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 270-271, 1990.

Descriptors: \*Groundwater pollution, \*Interagency cooperation, \*Local governments, \*Minnesota, \*Regulations, \*Water pollution control, Erosion control, Feedlot wastes, On-site wastewater treatment, Sinkholes, Solid waste disposal, Well regula-

In the early 1980's, Minnesota policymakers worked to establish a cooperative local-state effort in southeastern Minnesota to protect groundwater. Two task forces were formed for the purpose of Iwo task forces were formed for the purpose of considering new or stronger regulations concerning sinkholes, water wells, individual sewage systems, feedlots, erosion control and solid waste. The Comprehensive Local Water Planning Act was passed in 1985. Plan preparation is voluntary and the process is flexible. Each county develops its own plan but it must coordinate with other affective ed local entities. The plan must address ground-water and surface water and related issues, soil water and surface water and related issues, soil erosion, and special geologic conditions. It requires public participation in plan development. The newly developed Minnesota Ground Water Protection Act of 1989 strengthens Minnesota's groundwater policy framework; protects drinking water supplies; provides for education, research, monitoring, and information management; improves control of pollution sources; and provides a key role for local government. Local government has proven to be a valuable partner in the task of protecting groundwater resources. It is close to the protecting groundwater resources. It is close to the people, has broad land use and health authorities and uses the water. (Feder-PTT) W91-09895

# DIFFICULTIES CONFRONTING AN AGRI-CULTURAL PESTICIDE WASTE COLLEC-TION PROGRAM IN WISCONSIN.

Wisconsin Univ.-River Falls. Dept. of Plant and Earth Sciences.
For primary bibliographic entry see Field 5E.
W91-09896

# COORDINATED GROUNDWATER PROTEC-TION IN HEBRON, CONNECTICUT. Connecticut Dept. of Environmental Protection, Hartford. Bureau of Water Management.

J. Murphy.
Journal of Soil and Water Conservation JSWCA3,
Vol. 45, No. 2, p 272-273, 1990.

Descriptors: \*Connecticut, \*Groundwater pollution, \*Local governments, \*Regulations, \*Water pollution control, \*Zoning, Comprehensive planning, Hazardous wastes, Land development, Land use, Waste disposal, Water supply.

### Water Quality Control—Group 5G

In the early 1980's, Hebron was undergoing rapid and unanticipated expansion of residential and commercial development. The Planning and Zoning Commission recognized the potential water supply and waste disposal impacts of this growth and initiated a review of the town's zoning and subdivision regulations, zoning districts and plan of development. In response, new zoning reg-ulations and zoning districts were adopted includunations and zoming districts were another including addition of an aquifer protection overlay zone to protect a future water supply site, performance standards for high risk land uses, rezoning sensitive areas to lower risk categories and adoption of minimum buildable land criteria for new residential lots in unsewered areas. The Water Pollution Autority description of the protection of thority developed a sewer service plan that incor-porates the minimum buildable land criteria for areas that will not be sewered and directed sewer service to the community's existing and potential commercial and industrial districts. A conservation commercial and industrial districts. A conservation plan is being prepared that will be incorporated by reference into the zoning commission's plan of development. A household hazardous waste collection day and a hazardous material storage ordinance is in the process of development. (Feder-PTT) W91-09897

### STORMWATER RUNOFF POLICY ON THE SPOKANE/RATHDRUM PRAIRIE AQUIFER. Panhandle Health District 1, Coeur d'Alene, ID. E. O. Hale.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 273-274, 1990.

Descriptors: \*Environmental policy, \*Injection wells, \*Storm runoff, \*Storm water management, \*Urban runoff, \*Water pollution prevention, \*Wellhead protection, Aquifer management, Idaho, Nitrates, Washington, Waste disposal.

The Panhandle Health District, in conjunction with the Idaho Department of Water Resources, is developing a stormwater runoff control program under the U.S. EPA Wellhead Protection Program. The goal of the project is to protect the Spokane Valley/Rathdrum Prairie Aquifer from widespread subsurface disposal of stormwater runoff via shallow injection wells. Studies conductions runon via share where the weeks studies conductive do by the health district in 1976 and 1977 established that areas downgradient from urban land uses had elevated nitrate levels and that the aquifer is vulnerable to contamination from surface activities. The stormwater runoff controls are being developed in conjunction with similar programs, such as chemical storage and use, solid waste and subsurface sewage disposal. The expected result subsurface sewage disposal. The expected result will be a groundwater management system that protects the resource by preventing contamination rather than a program that responds to poor water quality with costly remedial action. (Feder-PTT) W91-09898

### WASTEWATER DISPOSAL AT FRUIT AND VEGETABLE PACKING FACILITIES IN DADE COUNTY, FLORIDA.

Department of Environmental Resources Management, Miami, FL. Agricultural Waste Program. For primary bibliographic entry see Field 5E. W91-09899

# LOCAL LAND USE PLANNING FOR RURAL GROUNDWATER PROTECTION IN VERMONT AND NORTHERN NEW YORK.

Vermont Univ., Burlington. School of Natural Re-

L. A. King, and G. R. Harris. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 310-314, 1990. 29 ref.

Descriptors: \*Groundwater pollution, \*Land use, \*Local governments, \*New York, \*Vermont, \*Water pollution control, Information exchange, Management planning, Ordinances, Regulations, Rural areas, Zoning.

An exploratory survey was conducted of land use planning for rural ground-water protection in 41 towns in Vermont and northern New York. Most

### Group 5G-Water Quality Control

communities have experienced contamination and/ or supply problems but lack the information necessary to take action to prevent problems in the sary to take action to prevent proteins in the future. Federal and state governments should im-prove communication with local governments in rural areas and provide more usable groundwater information. Planning officials perceive existing regulations to be ineffective for protecting groundwater. In view of local resistance to state tion and new regulations, an incremental approach it is recommended, incorporating groundwater pro-tection provisions into existing zoning or site plan review ordinances. (Author's abstract) W91-09901

# PROVIDING INFORMATION TO FARMERS FOR GROUNDWATER QUALITY PROTECTION.

Iowa Univ., Iowa City. Graduate Program in Urban and Regional Planning.

Urban and Regional Co. K. Contant.

Journal of Soil and Water Conservation JSWCA3,
Vol. 45, No. 2, p 314-317, 1990. 2 tab, 25 ref.

Descriptors: \*Agricultural practices, \*Education, \*Groundwater pollution, \*Information exchange, Groundwater pollution, \*Information exchange, \*Public participation, \*Water pollution control, Administrative agencies, Agricultural chemicals, Farm management, Groundwater quality, Iowa, Water conservation

Governmental programs seeking to protect groundwater quality have relied largely on information dissemination and farmer education to reduce agricultural chemical use. In this approach, providing persuasive information through the proper sources is critical to program effectiveness. Empirical evidence from studies conducted in Iowa suggests that three stages of information provision are needed: (1) to stimulate farmers' interest in groundwater quality problems, (2) to provide contact with alternative farm practices that reduce water or prevent groundwater contamination, and (3) to collaborate with farmers in the transition to these new practices. Sources of such information are identified for the three stages, respectively: local personnel of public resource agencies, social/ professional groups and field demonstrations and private crop consultants and retrained Extension private crop consultants and retrained Extension personnel. This targeting of information through appropriate sources capitalizes on farmer informa-tion needs and provides a coordinated program of governmental action designed to improve the effectiveness of dissemination between and to farmers about groundwater quality protection. (Author's abstract) W91-09902

# PATTERNS OF SOIL NITRATE AVAILABIL-ITY IN CORN PRODUCTION SYSTEMS: IM-PLICATIONS FOR REDUCING GROUNDWAT-ER CONTAMINATION.

yland Univ., College Park. Dept. of Agricul-For primary bibliographic entry see Field 5B. W91-09903

### LANDOWNER PERCEPTIONS OF SINK-HOLES AND GROUNDWATER CONTAMINA-TION.

Iowa Natural Heritage Foundation, Des Moines. G. Huber.
Journal of Soil and Water Conservation JSWCA3,

Vol. 45, No. 2, p 323-327, 1990. 2 fig, 6 ref.

Descriptors: \*Agricultural runoff, \*Groundwater pollution, \*Karst, \*Sinkholes, \*Water pollution pollution, \*Karst, \*Sinkholes, \*Water pollution control, \*Water pollution sources, Agricultural chemicals, Farm management, Farm wastes, Feedlot runoff, Groundwater quality, Tile drainage.

Sinkholes allow harmful materials to enter groundsanknotes attook narmum materiats to enter ground-water aquifers in karst areas. Interviews with Iowa farmers having sinkholes found widespread recog-nition that sinkholes threaten groundwater quality. Farmers indicated that runoff into sinkholes was mon as was material disposed, feedlot runoff and tile drainage. Most farmers expressed concern about runoff into sinkholes. The most acceptable practices to control such runoff were reduced chemical use, plugging, filter strips, diversions and contour stripcropping. Practices considered most effective were permanent seeding of drainage areas and elimination or reduction in farm chemical use. Most farmers were unlikely to enroll land in the Conservation Reserve Program (CRP) if available for sinkhole areas because participation would be inconvenient or because they had small farms and needed the land to remain economically viable. Two modifications of CRP are suggested. Farmers wanted slightly more than full land value for con-servation easements to establish trees around sinkholes because they felt there would be no return from the trees in their lifetime. They also considered about 70% of full land values reasonable for easements restricting use to forages because they felt this was a fair value for the change to permanent forages. (Author's abstract) W91-09904

# EXPERT OPINION AND GROUNDWATER QUALITY: THE CASE OF AGRICULTURAL DRAINAGE WELLS.

Minnesota Univ.-Duluth. Dept. of Geography. For primary bibliographic entry see Field 5B.

#### USING THE CONSERVATION RESERVE PRO-GRAM TO PROTECT GROUNDWATER QUAL-ITY.

Economic Research Service, Washington, DC. W. Huang, K. Algozin, D. Ervin, and T. Hickenhotham

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 341-346, 1990. 3 tab, 17 ref.

Descriptors: \*Alternative planning,
Reserve Program, \*Cropland, \*Environmental
policy, \*Fertilizers, \*Groundwater pollution,
\*Groundwater quality, \*Legislation, \*Nitrates,
\*Coundwater quality, \*Legislation, \*Pesticides, \*Water
\*Cost-henefit anal-Policy, \*Fertilizers, \*Groundwater pollution, \*Groundwater quality, \*Legislation, \*Nitrates, \*Nonpoint source pollution, \*Pesticides, \*Water policy, \*Water pollution control, Cost-benefit analysis, Farm income, Population exposure.

Five policy strategies aimed at retiring 10 million acres of cropland that overlies groundwater vulnerable to pesticides in the Conservation Reserve Program (CRP) are investigated. Strategies include marginal land retirement, retirement of the most vulnerable cropland, minimizing human exposure to groundwater contamination, minimizing pesticide use, and targeting current CRP-eligible cropland. The marginal land retirement strategy has the lowest average national rental rate, while the minilowest average national rental rate, while the mini-mizing pesticide use strategy has the highest rate. The Appalachian and Southeast regions generally show relatively low rental rates. These two regions possess large amounts of highly vulnerable crop-land. Each strategy improves net farm income in most regions except in the Northeast. The net income in this region drops 17% under the minimizing human exposure strategy because a large portion of cropland in that region is removed from production. If the objectives of expanding the current CRP to protect groundwater quality also include helping farmers in regions where they are experiencing low returns from farming, a strategy that focuses on the Appalachian, Southeast and Delta States regions would be desirable. (Author's abstract) W91-09908

### CONTAMINATION VULNERABILITY INDEX-ES: A WATER QUALITY PLANNING TOOL. South Dakota State Univ., Brookings. G. Lemme, C. G. Carlson, R. Dean, and B.

Khakural.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 349-351, 1990. 6 ref.

Descriptors: \*Land management, \*Land use, \*Management planning, \*Risk assessment, \*Water pollution control, \*Water resources management, Agricultural runoff, Aquifers, Geological data, Soil surveys, Surface water, Terrain analysis.

Landscapes vary in their ability to protect associated surface waters and underlying aquifers. When coupled with land use data, vulnerability assessments allow managers to target those landscapes that pose the greatest risk to water quality. Soil and geologic data from a 7.5 minute topographic quadrangle were integrated to formulate surface and aquifer water vulnerability index values. The process is designed for easy implementation. Vulnerability assessment information can be displayed nerability assessment information can be usipalyed in map or numeric form. Water resource vulnerability assessment must take a holistic approach by integrating soil, geology, and land use information. Water resource vulnerability assessments, when considered with land management alternatives, can result in the development of agricultural production schemes that protect water resources from contamination by agricultural inputs. (Author's abstract) W91-09910

# STUDIES ON MITIGATION OF THE EFFECTS OF ACIDIC PRECIPITATION ON ADULT ATLANTIC SALMON (SALMO SALAR)-INTRO-

Department of Fisheries and Oceans, Halifax (Nova Scotia). Physical and Chemical Sciences Branch J. F. Uthe.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2420-2421, December 1990. 5 ref.

Descriptors: \*Acid rain, \*Acidification, \*Hydro-gen ion concentration, \*Liming, \*River restora-tion, \*Water pollution effects, \*Water pollution treatment, Buffering, Field tests, Fish diets, Fish reproduction, Path of pollutants, Rivers, Salinity, Salmon Stream fisheric Salmon, Stream fisheries.

Many poorly buffered river systems in southwest-ern Nova Scotia are now devoid of Atlantic salmon (Salmo salar) populations due to their acidi-fication by atmospheric deposition. The efficacy of dietary modification and restoration of more neutral conditions was investigated by passing acidic river water through a bed of calcium carbonate upstream of a holding facility. Results of these cooperative studies have shown that neither dietary salt nor liming were completely effective at maintaining normal, sexual maturing adult Atlantic salmon. The inability of pH restoration, with limestone, to mitigate the observed effects suggests that acid precipitation results in other toxic materials being present in acidified poorly buffered river systems, or that limestone treatment has a detri-mental effect, either directly or through the inability of the experimental system to avoid small mag-nitude but sudden pH changes, such as that result-ing from daily raking. (See W91-10002 thru W91-10005) (Brunone-PTT) W91-10001

### EFFECTS OF DIET OR LIMING ON STEROID HORMONE METABOLISM AND REPRODUC TION IN ATLANTIC SALMON (SALMO SALAR) HELD IN AN ACIDIC RIVER.

Department of Fisheries and Oceans, Halifax (Nova Scotia). Physical and Chemical Sciences Branch.

G. B. Sangalang, H. C. Freeman, J. F. Uthe, and

G. D. Sangaian, N. L. S. Sperry. Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 47, No. 12, p 2422-2430, December 1990. 7 fig. 5 tab, 25 ref.

Descriptors: \*Acid rain, \*Acid streams, \*Acidifica-Descriptors: "Acid rain, "Acid streams, "Acidifica-tion, "Fish diets, "Fish physiology, "Fish repro-duction, "Liming, "Water chemistry, "Water pol-lution treatment, Comparison studies, Field tests, Fish metabolism, Hydrogen ion concentration, Medway River, Nova Scotia, Path of pollutants, Sodium chloride, Steroids, Stream fisheries, Toxic-ity, Water pollution effects, Westfield River.

Attempts to avert the impact of an acidic river Attempts to avert the impact of an acidic river environment on Atlantic salmon (Salmo salar) were carried out in 1985 and 1986. Salmon were held in the Westfield River (pH 4.7 to 5.2) and the nearby Medway River (pH 5.3 to 5.6), in southwestern Nova Scotia, during their sexual maturation. A diet containing 3% sodium chloride was fed to the Westfield salmon in 1985. Marble chips were used to elevate the pH of Westfield River in were used to elevate the pH of Westfield River

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1986. Fish fed the salt diet had higher peak levels of plasma sex hormones, higher fecundity, greater incidence of spawners, lower egg mortality, and less weight loss than fish fed a commercial trout diet. The reproductive performance of fish held in limed water (pH 5.1 to 5.9) almost attained the level observed in the Medway (control) fish. Limetevel observed in the Medway (control) itsn. Lime-stone treatment stimulated early peaking of blood androgen levels, testosterone, and 11-ketotestoster-one in Westfield males, and 17 alpha, 20 beta-dihydroxy-4-pregnen-3-one, a follicular mediator of gonadotropin, in a few Westfield females. The head kidneys produced more cortisol and corticos-terone in all Westfield fish in both years compared terone in an westied insin noon years compared to Medway fish. The results suggest that neither dietary salt nor liming completely prevented the decline of reproductive performance and the alter-ation of steroid hormone metabolism in salmon. The limestone treatment restored the pH of the Westfield River water to that of the Medway River, suggesting that either other toxic materials are present in untreated Westfield River water in addition to hydronium ion, or that limestone treatment has an adverse effect. (See W91-10001 and W91-10003 thru W91-10005) (Author's abstract)

RESPONSES OF PLASMA ELECTROLYTES, THYROID HORMONES, AND GILL HISTOLOGY IN ATLANTIC SALMON (SALMO SALAR) TO ACID AND LIMED RIVER WATERS.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst. Department of Fisheries and Oceans, Wanning, (Manitoba), Freshwater Inst.
S. B. Brown, R. E. Evans, H. S. Majewski, G. B. Sangalang, and J. F. Klaverkamp.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2431-2440, December 1990. 6 fig, 1 tab, 61 ref.

Descriptors: \*Acid rain effects, \*Acid streams, \*Acidification, \*Electrolytes, \*Fish physiology, \*Gills, \*Histology, \*Hormones, \*Liming, \*Salmon, \*Water pollution effects, \*Water pollution treatment, Acid rain, Comparison studies, Field tests, Medway River, Nova Scotia, Path of pollutants, Rivers, Salinity, Sodium, Sodium chloride, Stream fisheries, Thyroid, Westfield River.

Sexually maturing Atlantic salmon, (Salmo salar) were held in the acidic (pH 4.7 to 5.2) Westfield River, Nova Scotia and in the nearby, less acidic (pH range 5.2 to 5.6) Medway River. Exposure to Westfield River water in 1985 (149 days) and 1986 (126 days) reduced plasma osmolality, sodium ions, chloride ions, and Ca(2+) (in females only) concentrations of post-spawning fish compared to those in fish held in the Medway River. Coincidenal increases in plasma potassium ions, glucose, and unidentified osmotic fraction. Gill tissue showed hyperplasia of primary lamellae epithelium. Together, these findings indicate compromised ionorgether, these findings indicate compromised ionor-egulatory ability. Decreased plasma T3 (3,5,3'-tri-lodo-L-thyronine) suggests altered thyroid func-tion. Westfield River water did not affect plasma T4 (L-thyroxine) or protein concentrations. An unintentional handling stress caused even more severely depressed plasma ions and more elevated plasma glucose in Westfield fish in 1985 relative to 1986; Medway fish largely recovered from this stress. These observations indicate that acid-ex-1986; Medway itsi angles indicate that acid-exposed fish may be more sensitive to additional regulatory ability but did not affect plasma T3 and Ca(2+) (female). A high salt diet (3% sodium chloride) failed to protect salmon from the effects of acidic water. (See W91-10001 and W91-10002, W91-10004, W91-10005) (Author's abstract)

MORPHOMETRIC EFFECTS OF LOW PH AND LIMED WATER ON THE GILLS OF AT-LANTIC SALMON (SALMO SALAR).

LANHU SALMUN (SALMU SALAR).

Maine Univ. at Orono. Dept. of Zoology.

C. H. Jagoe, and T. A. Haines.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2451-2460,

December 1990. 1 fig. 8 tab, 72 ref. US DOE

Contract No. DE-AC09-76R00-819.

Descriptors: \*Acid rain effects, \*Acidification, \*Fish pathology, \*Gills, \*Hydrogen ion concentra-

tion, \*Liming, \*Morphometry, \*Salmon, \*Water pollution effects, Water pollution treatment, Acid rain, Comparison studies, Cytology, Field tests, Medway River, Nova Scotia, Path of pollutants, Stream fisheries, Uptake rates, Westfield River.

Gills from adult Atlantic salmon held in water from an acid water (Westfield River, Queens County, Nova Scotia; mean pH 4.8) were compared to gills from fish held in a nearby control river (Medway River; mean 5.4). Morphometic analysis showed that fish held in the acidic water had more gill chloride cells and mucous cells than those held in the limed water or the control river. The difference in chloride cell number was due to increased numbers of cells on the primary lamellar epithelium; numbers of the secondary lamellae did not increase with acid exposure. Male fish were found to have more chloride cells on their second-ary lamellae than female fish. Chloride cells were ary lamellae than female fish. Chloride cells were larger and more nearly spherical in shape in the fish exposed to low pH water. The liming treatment was partially effective in preventing changes in gill histology. Changes in size, shape, and number of chloride cells probably represent a response of increasing ionic uptake to offset the loss of ions occurring during low pH stress. (See W91-10001 thru W91-10003 and W91-10005) (Author's bettreat). abstract) W91-10004

RESPONSES OF KIDNEY, LIVER, MUSCLE, AND BONE IN ATLANTIC SALMON (SALMON SALAR) TO DIET AND LIMING IN ACIDIC NOVA SCOTIA RIVERS.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.

(Manitoba). Freshwater Inst. H. S. Majewski, S. B. Brown, R. E. Evans, H. C. Freeman, and J. F. Klaverkamp. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 12, p 2441-2450, December 1990. 5 fig, 68 ref.

Descriptors: "Acid rain, "Acidification, "Fish physiology, "Hydrogen ion concentration, "Liming, "Nova Scotia, "Salmon, "Water pollution effects, "Water pollution treatment, Acid-soluble thiols, Animal metabolism, Ascorbic acid, Bones, Comparison studies, Cytology, Field tests, Kidneys, Liver, Medway River, Muscle, Uptake rates, Westfield River.

Atlantic salmon (Salmo salar) populations have either declined or disappeared entirely from a number of rivers in southwestern Nova Scotia due number of rivers in southwestern Nova Scotia due to acidification of these soft and poorly buffered waters. Two-year old sexually maturing Atlantic salmon (Salmo salar) were held in the Medway (pH range 5.2 to 5.6) and Westfield (pH range 4.7 to 5.2) rivers of Nova Scotia for 149 and 126 days respectively, in successive years (1985 and 1986). Exposure to Westfield river water resulted in a depletion of renal and hepatic acid-soluble thiol (AST) and of renal ascorbic acid (AsA) reserves in both weare I invite or the feating of a high-salt both years. Liming, or the feeding of a high-salt (3.0% sodium chloride) diet, failed to completely maintain these reserves at levels found in Medway river salmon. In 1986 declines in bone (Ca and P) and muscle (Na and K) electrolytes were coincidental to elevations in liver glycogen, suggesting that gluconeogenesis was an adaptive mechanism in response to the ionoregulatory effects associated with acidic and low ambient calcium conditions. The addition of lime to Westfield river water reon depleted bone Ca and P levels, but had no effect on depleted bone Ca and P levels. (See W91-10001 thru W91-10004) (Author's abstract) W91-10005

CHERNOBYL ACCIDENT RAISES A CONCERN REGARDING THE PROTECTION OF GROUND WATER.

Leighton and Associates, Inc., Irvine, CA.
For primary bibliographic entry see Field 5B.
W91-10044

MANAGING TROUBLED WATERS: THE ROLE OF MARINE ENVIRONMENTAL MON-ITORING. National Research Council, Washington, DC.

Committee on a Systems Assessment of Marine Environmental Monitoring. National Academy Press, Washington DC. 1990. 125p.

Descriptors: \*Environmental monitoring, \*Environmental policy, \*Environmental protection, \*Marine environment, Case studies, Chesapeake Bay, Coastal waters, Model studies, Monitoring, Southern California Bight, Waste disposal.

More than \$133 million is spent on marine environmental modeling annually in the United States, and yet officials still do not have enough accurate information to make timely decisions about pro-tecting coastal waters. This book presents a comprehensive overview of marine monitoring and provides practical information and a model for revamping the nation's marine monitoring system. This book: explores current monitoring programs and evaluates whether they do or do not work; examines the benefits and limitations of monitoring, with case studies of successful programs and a ing, with case studies of successful programs and a 10-step agenda for strengthening monitoring's role in environmental management; describes the critical need for greater coordination among monitoring programs, with case studies of programs in the Chesapeake Bay and the Southern California Bight, and an analysis of particulate waste disposal; and recommends steps for designing and developing more effective monitoring programs. (Lantz-PTT) W91-10061

REVISED PROCEDURAL GUIDE FOR DESIGNATION SURVEYS OF OCEAN DREDGED MATERIAL DISPOSAL SITES.

LGL Ecological Research Associates, Inc., Bryan,

W. E. Pequegnat, B. J. Gallaway, and T. D.

Available from the National Technical Information Service, Springfield, VA. 22161 as ADA 222236. Price codes: A12 in paper copy A02 in microfiche. Army Corps of Engineers Technical Report D-90-8, April 1990. Final Report. 259p, 4 fig, 32 tab, 102 ref, 6 append. U.S. Army Contract DACW39-87-

Descriptors: \*Dredging wastes, \*Ocean dumping, \*Standards, \*Waste disposal, Continental shelf, Data acquisition, Dredging, Field tests, Handbooks, Oceanography, Sampling methods.

This procedural guide is a revision of that issued in Inis procedural gude is a revision of that issued in 1981 and has been prepared to meet the needs of the Corps of Engineers in conducting surveys for the designation of ocean disposal sites for dredged material. Basic purposes of the guide are to provide detailed information on evaluation of oceanographic parameters, collection of field samples, and performance of laboratory analyses. Another objective is to clarify the role of the monitoring program that may be instituted at each site pursuant to final site designation and to relate its content to the original site survey. Because the scientific content of the surveys is, in part, related to physi-cal characteristics of the sites, such as size, depth of water, and distance from shore, these characteristics as they pertain to sites in the various Corps Districts are discussed in detail. There is also a discussion of the common features of the oceanog-raphy of the US continental shelf because over 80% of existing sites are located on the shelf. A substantial portion of the guide is devoted to the selection of variables to be measured in the field and the rationale for placement of sampling stations, as well as gear appropriate to various condi-tions. Detailed guidance is given on the preferred tions. Detailed gudantee is given on the preferred methods of sample analysis, including biological, physical, chemical, and geological methodologies. Suggestions are given for effective presentation of the field and laboratory data generated during the site survey. Because site designation does not, in itself, include the disposal of dredged material, the methodologies are, so far as possible, compatible with those used for the evaluation of material proposed for disposal. Although site designation, evaluation of material for disposal, and monitoring are separate activities, they are part of a continuum and should share common techniques so as to be

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cost-effective and of maximum technical validity. (Author's abstract) W91-10068

# USE OF FLEXIBLE MEMBRANE LINERS IN HAZARDOUS AND NONHAZARDOUS LAND-

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. For primary bibliographic entry see Field 5E. W91-10077

### SUPERFUND RECORD OF DECISION: ALAD-DIN PLATING, PA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206346. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/062, September 1988. 21p, 2 fig, 1 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Pennsylvania, \*Superfund, \*Water pollution sources, Arsenic, Cadmium, Containment, Costs, Drinking water, Hazardous wastes, Heavy metals, Lead, Soil contamination.

The 2 acre Aladdin Plating site is a former electro-plating facility located in Scott and Abington Townships, Lackawanna County, PA, 1.5 mi north of the Town of Chinchilla. Approximately 11,000 people within 3 mi of the site use domestic and people within 3 m of the site use domestic and public groundwater wells for drinking water. Site runoff flows northwest toward Leggetts Creek, a principal tributary of Griffin Pond Reservoir. Leg-getts Creek and Griffin Pond are sources of supple-mental drinking water for more than 100,000 people. Hazardous materials used in operations inpeople. Hazardous materials used in operations in-cluded sulfuric acid, chromic acid, cyanide, chro-mium, and other heavy metals. For 35 yrs, electro-plating waste effluents containing heavy metals and other contaminants were discharged via a ditch and underground pipes to a shallow surface lagoon near the electroplating building. A fire de-stroyed the facility and ended operations in 1982. Three source areas of contamination have been identified: the site of the former plating facility building, a buried trench, and the lagoon. Groundbuilding, a buried trench, and the lagoon. Ground-water samples from on-site monitoring wells showed significant levels of arsenic, cadmium, chromium, and lead; all exceeded their respective maximum contaminant levels. In March 1987, EPA performed emergency response activities to remove significant immediate health threats. These remove significant immediate nearth threats. These responses included fencing contaminated zones and removing drums and vats containing hazardous wastes. This response action addresses only the remediation of the contaminated soil on-site. The remediation of the contaminated soil on-site. The groundwater contamination will be addressed in a subsequent remedial action. The primary contaminants of concern affecting the soil and groundwater are arsenic, chromium, and lead. The selected remedial action for this site includes: excavation and off-site stabilization of approximately 12,000 cu yd of contaminated soil, with disposal of the treated soil in an off-site landfill and replacement of the excavated soil with clean fill. The estimated present worth cost for this remedial action is \$4,461,000 with no associated operation and maintenance costs. (Author's abstract) W91-10082

#### SUPERFUND RECORD OF DECISION: CIBA-GEIGY, NJ.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-229546. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-89/076, April 1989. 169p, 21 fig, 10 tab, 2 append.

Descriptors: \*Cleanup operations, \*New Jersey, \*Superfund, \*Water pollution sources, Aquifers, Benzene, Costs, Groundwater pollution, Heavy metals, Industrial wastes, Organic compounds, Reverse osmosis, Site remediation, Toms River, Volatile organic compounds.

The Ciba-Geigy Chemical Corporation site is located in Dover Township, Ocean County, New Jersey. The Toms River, which derives surface water primarily through groundwater basin flow, runs through the northeast sector of the property. The comment disposed of chemical waster oracite. runs through the northeast sector of the property. The company disposed of chemical wastes on-site in several locations, including: a 5.2 acre drum disposal area (containing approximately 100,000 drums); a 39 acre lime sludge disposal area (used for disposal of inorganic wastes); a 12 acre filter cake disposal area (which received sludge from the wastewater treatment); five heaffiled lagrouss. wastewater treatment); five backfilled lagoons comprising 8.5 acres; and, a calcium sulfate dispos-al area. Groundwater contamination is migrating from these now inactive disposal sites easterly toward the Toms River. In 1984, after discovering that Ciba-Geigy was illegally disposing of drums containing liquids and hazardous waste in the land-fill, the State ordered Ciba-Geigy to remove 14,000 drums. In 1985, leaking equalization basins associated with the wastewater treatment plant led to Ciba-Geigy closing the basins and beginning reme-diation of the contaminated plume from those basins. Currently, contaminants are present in leaking drums, waste sludges, soils, and groundwater. This Record of Decision addresses the first operable unit focusing on the remediation of groundwater contamination in the upper aquifer. Remediation of the on-site source areas and deeper aquifer (if needed) will be addressed in future operable units. The primary contaminants of concern affecting the groundwater are volatile organic compounds in-cluding benzene, tetrachloroethylene, trichloroethylene, and toluene; and, metals including arsenic and chromium. The selected remedial action for this site includes sealing contaminated residential irrigation wells; on-site and off-site groundwater irrigation wells; on-site and out-site groundwater pumping with on-site treatment using filtration, reverse osmosis, and granular activated carbon in an upgraded version of the Ciba-Geigy wastewater treatment plant, followed by temporarily retaining the groundwater in basins for monitoring and subsequent discharge to the Toms River; and implementation of a river and groundwater monitoring program. The estimated present worth cost for this remedial action is \$164,500,000 which includes annual operation and maintenance costs of \$12,539,000. (Lantz-PTT) W91-10083

### ONCHOCERCOSE, HYDROLOGY AND SAT-ELLITE TELEMETRY (ONCHOCERCOSE, HY-DROLOGIE ET TELETRANSMISSION).

Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). B. Pouyaud, and L. Le Barbe.

In: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 239-244.

Descriptors: \*Human diseases, \*Onchocerciasis, \*Public health, \*Remote sensing, \*Satellite technology, \*Streamflow forecasting, Diseases, Insecticides, Regional analysis, River flow, River forecasting, Stream gages

1971, the World Health Organization (WHO) has set up a program to combat onchocer-ciasis, a disease spread through gnats. The WHO program is thus based on insecticide treatments of the midge larvae in the rivers. The knowledge of river flows is necessary to allow an appropriate insecticide dosage. River flows were estimated using a conventional runoff measurement network along with the data provided by a few specific stations and complementary stream gaging. The next step is an extension of the program to regions whose accessibility is more difficult and to a broad diversity of hydrological regimes. This requires the implementation of a stream gage network, using satellite telemetry to allow real-time flow forecasting and a better quantification of insecticide treatments. These methodological and technical solutions were adopted by WHO from suggestions by the Office de la Recherche Scientifique et Technique Outre-MER (ORSTOM). (See also W91-10103) (Author's abstract) (Fish-PTT)

### WASTE CONTAINMENT SYSTEMS: CONSTRUCTION, REGULATION AND PERFORM-ANCE.

For primary bibliographic entry see Field 5E. W91-10150

#### LANDFILL CONTAINMENT SYSTEMS REGU-LATIONS.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. For primary bibliographic entry see Field 5E. W91-10151

# REGULATION, CONSTRUCTION AND PER-FORMANCE OF CLAY-LINED LANDFILLS IN

Wisconsin Dept. of Natural Resources, Madison. M. E. Gordon, P. M. Huebner, and G. R. Mitchell. IN: Waste Containment Systems: Construction. Regulation and Performance. Geotechnical Specia Publication No. 26. American Society of Civil Engineers, New York. 1990. p 14-29. 2 fig, 2 tab,

Descriptors: \*Clay liners, \*Groundwater pollution, \*Landfills, \*Leachates, \*Liners, \*Regulations, \*Solid waste disposal, \*Waste management, \*Water pollution prevention, \*Wisconsin, Design criteria, Monitoring, Performance evaluation.

The Wisconsin Department of Natural Resources has required the use of thick clay liners (1.5 m) combined with a leachate collection system as a means of groundwater protection at municipal and non-hazardous industrial solid waste landfills for almost 15 years. During this period, approximately 85 solid waste disposal facilities have been ap-proved using this design strategy. Operational ex-perience along with data generated from environ-mental monitoring of many of these facilities have mental monitoring of many of these facilities have provided a substantial amount of information regarding the performance of clay-lined landfills. Based upon this data it is concluded that properly designed and constructed clay liners along with an efficient leachate collection system can provide a efficient reachate collection system can provide a high level of groundwater protection at solid waste disposal facilities. However, the technology remains developmental and may require further modifications in the future as additional performance data become available. (See also W91-10150) (Geiger-PTT) W91-10152

#### PERFORMANCE EVALUATION OF EARTH-EN LINERS.

Trautwein Soil Testing Equipment Co., P.O. Box 31429, Houston, TX 77231.
For primary bibliographic entry see Field 5E. W91-10153

### FIELD BEHAVIOR OF DOUBLE-LINER SYS-

GeoSyntec Consultants, Norcross, GA. For primary bibliographic entry see Field 5E. W91-10154

### DETAILED CASE HISTORY OF CLAY LINER PERFORMANCE.

Golder Associates, Mississauga (Ontario). For primary bibliographic entry see Field 5E. W91-10158

## ATTENUATING MATERIALS IN COMPOSITE LINERS.

Bucknell Univ., Lewisburg, PA. Dept. of Civil

Engineering.

J. C. Evans, Y. Sambasivam, and S. Zarlinski.

IN: Waste Containment Systems: Construction, Regulation and Performance. Geotechnical Special Publication No. 26. American Society of Civil Engineers, New York. 1990. p 246-263. 9 fig, 36

Descriptors: \*Clay liners, \*Clay minerals, \*Geotextiles, \*Hazardous waste disposal, \*Landfills, \*Liners, \*Solid waste disposal, \*Water pollution

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prevention, Bentonite, Design criteria, Fly ash, Geosynthetics, Leachates, Materials testing, Solute transport. Zeolites.

Liners for hazardous and solid waste landfills are presently designed to minimize advective contami-nant transport. A typical hazardous waste liner system consists of compacted clay overlain by a secondary geomembrane liner, a secondary leachate collection system, a primary geomembrane liner and a primary leachate collection system. The inter and a primary leachate collection system. The thickness of the attenuating layers will depend upon the hydraulic conductivity, hydraulic head, chemical potential, effective diffusivity, retardation factor and design requirements defining allowable breakthrough time and steady state transport rates. The method of calculation can be based upon the The method of calculation can be based upon the analytical solution to the advective-dispersive equation for solute transport. A composite liner is proposed that would be more effective in minimizing the rate of contaminant transport in comparison to liners presently used. The conceptual composite liner system would consist of compacted clay overlain by a soil/organo-clay (or fly ash) admixture, a soil/zeolite (or bentonite) admixture, a socionary geometrape liner a secondary. admixture, a sour/zeonic (or enconice) admixture, a secondary geomembrane liner, a secondary leachate collection system, a primary geomembrane liner, and a primary leachate collection system. Organically modified clays adsorb organic molecules by adsorbate interactions and adsorbatesolvent interactions. Studies using a soil-bentonite and fly ash composite in liners showed that the breakthrough time may be delayed by decades by increasing the adsorptive capacity of the liner system. Additional study is required to optimize the design of composite liner systems in order to maximize breakthrough time and minimize diffusive transport rates for a cost-effective barrier system. (See also W91-10150) (Geiger-PTT) W91-10162

MORPHOLOGY AND MICROCHEMISTRY OF SOLIDIFIED/STABILIZED HAZARDOUS WASTE SYSTEMS.

Louisiana State Univ., Baton Rouge. Dept. of Chemistry. For primary bibliographic entry see Field 5E. W91-10233

STATUS REPORT ON REMEDIAL INVESTI-GATION OF THE 300 AREA PROCESS PONDS, Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5B. W91-10237

MANAGEMENT REVIEW OF THE SUPER-FUND PROGRAM: IMPLEMENTATION PLAN.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-153883. Price codes: A08 in paper copy, A01 in microfiche. Report No. EPA 540/8-89/009, September 1989. 169p.

Descriptors: \*Cleanup operations, \*Management planning, \*Superfund, \*Waste management, \*Water pollution treatment, Information transfer, Long-term planning, Personnel, Project planning, Regional planning, Regulations, Short-term planning, Site remediation.

The Superfund 90-day study set forth a comprehensive long-term strategy for the Superfund program. The basic elements of the strategy are to: gram. Ine basic elements of the strategy are to: control acute threats immediately, deal with the worst sites and worst problems first; carefully monitor and maintain sites over the long-term; emphasize enforcement to induce private party cleanup; seek new technologies for more effective cleanup; improve the efficiency of program operations; and encourage full participation by commu-nities. Regions are already implementing the re-commendation to issue more unilateral orders for remedial action. Twenty-one such orders have remedial action. I wenty-one such orders have been issued this fiscal year, a major increase over last year's entire production and more are expected by the end of this fiscal year. These orders are resulting in the conduct of approximately \$150

million worth of remedial work by potentially responsible parties. By October 1, 1989, Superfund will begin collecting data on environmental indicators which will help to show the progress being made to protect public health and the environment through this program. Communication forums to inform the public on program progress at all levels are being scheduled for the first quarter of the fiscal year. In the near term, the Agency will be routinely engaged in dialogue with Congressional staff, not only on specifically requested deadline compliance information, but also on reporting progress with the Implementation Plan. (Lantz-PTT) W91-10238

IN-SITU STABILIZATION/SOLIDIFICATION

IN-SILU SIABILIZATION/SOLIDIFICATION OF PCB-CONTAMINATED SOIL.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
S. Sawyer, and M. K. Stinson.
Available from the National Technical Information Service Springfield Val 2015 pp. 1990 11320

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-113291. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/119, 1989. 10p, 2 tab,

Descriptors: \*Cleanup operations, \*In situ treatment, \*Polychlorinated biphenyls, \*Soil contamination, \*Waste solidification, \*Waste stabilization, Costs, Florida, Leachates, Leaching, Mixing, Organic compounds, Permeability, Physical treatment

Under the SITE program, a demonstration has been performed on an in situ stabilization/solidification process utilizing deep-soil-mixing equip-ment. This was the first field demonstration of an in situ stabilization/solidification process. The demonstration occurred in April 1988 at the site of a General Electric Co. electric service shop in Hialeah, Florida, where the soil contained polychlorinated biphenyls (PCBs) and localized con-centrations of volatile organics and heavy metal contaminants. The demonstrated process mixed the contaminanted soil in situ with a cementitious proprietary additive, called HWT-20, and water. The technical criteria used to evaluate the effectiveness technical criteria used to evaluate the effectiveness of the process were contaminant mobility measured by leaching and permeability tests and the potential integrity of solidified soils indicated by measurements of physical and microstructural properties. Performance of the deep-soil-mixing equipment was also evaluated. The process appeared to immobilize PCBs. However, due to the very low PCB concentrations in the leachates, caused in part by the low concentrations of PCBs caused in part by the low concentrations of PCBs. caused in part by the low concentrations of PCBs in the soils, confirmation of PCB immobilization was not possible. Physical properties were satisfactory except for the freeze/thaw weathering tests, where considerable degradation of the test specimens occurred. The microstructural analysis process produced a dense, homogeneous mass with low ess produced a dense, nomogeneous mass wint tow porosity, which shows a potential for long-term durability. The deep-soil-mixing equipment per-formed well, with only minor difficulties encoun-tered, which can be easily corrected. The HWT-20 additive was well dispersed into the soil, as evi-denced by the relatively uniform change in chemidenced by the relatively uniform change in chemi-cal and physical characteristics of treated versus untreated soils. The estimated remediation cost with operation of the 1-auger machine, used for the demonstration, is \$194/ton (\$150/cu yd). For larger applications, using, the 4-auger machine, costs would be lower. (Author's abstract) W91-10239

DRILLING AND PRODUCTION DISCHARGES AND OIL SPILLS IN THE MARINE ENVIRONMENT.

Minerals Management Service, Vienna, VA. Atlantic OCS Region.
For primary bibliographic entry see Field 5B.
W91-10254

HEALTH ASSESSMENT FOR: SOUTH ANDO-VER, ANDOVER, MINNESOTA. Agency for Toxic Substances and Disease Regis-try, Atlanta, GA.

Available from the National Technical Information

Service, Springfield, VA. 22161, as PB90-107350. Price codes: A03 in paper copy, A01 in microfiche. CERCLIS No. MND980609614, April 6, 1989. 10p, 8 ref, 2 append

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Path of pollutants, \*Public health, \*South Andover Site, Air pollution, Aquifers, Ex-traction, Metals, Minnesota, Monitoring, Phal-lates, Site remediation, Soil contamination, Wells.

The South Andover National Priorities List (NPL) Site is located in Andover, Minnesota. The site is located in a semi-industrial area characterized by located in a semi-industrial area characterized by used car dealerships, and auto part and salvage operations. The surficial aquifer is contaminated with volatile organic compounds (VOCs), bis (2-ethylhexyl) phthalate (DEHP), and metals. The contamination present in the soil, deeper aquifer, air, and biota has not been fully characterized. The remedy chosen in the Record of Decision (ROD) signed March 1988 includes: extraction of ground-water from the surficial aquifer, provision of mu-nicipal water to private well users on or near the site, provision of a groundwater monitoring system, and restrictions on new wells on or near the site. A supplemental Remedial Investigation and Feasibility Study (RI/FS) will be conducted in 1989. Removal of tires, which cover much of the site, is ongoing. This removal is to be completed in the spring of 1989. (Author's abstract)

SUPERFUND RECORD OF DECISION: AMBLER ASBESTOS, PA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206189. Price codes: A09 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/057, September 1988. 182p, 13 fig, 16 tab, append.

Descriptors: \*Asbestos, \*Asbestos Site, \*Cleanup operations, \*Site remediation, \*Superfund, \*Water pollution treatment, Costs, Drainage, Erosion control, Pennsylvania, Revegetation, Riprap, Sediment contamination, Waste disposal.

The Ambler Asbestos Piles site is located in the southwestern portion of the Borough of Ambler, Pennsylvania. The site is bordered on the west by Wissahickon Creek and its flood plain. The site consists of four distinct areas of asbestos contami-nation: the Locust Street Pile, the Plant Pile, the nation: the Locust Street Pile, the Plant Pile, the Pipe Plant Dump, and the asbestos settling basins/filter bed lagoons. The primary wastes generated and disposed of at these sites, by the consecutive site owners (the K and M Company, and Nicolet Industries) were magnesium/calcium, and asbestos process waste. In 1984, EPA implemented emergency response actions to establish a soil and vegetative cover, install a drainage system, and provide erosion control measures over the Locust Pile. In addition, Nicolet had covered the Plant Pile by June 1984. The primary contaminant of concern affecting the sediments, surface water, and debris is asbestos. The selected remedial action for this site includes: installation of a geotextile and soil cover ansbestos. The selected remedial action for this site includes: installation of a geotextile and soil cover on the exposed areas of waste piles; pump and treatment (using filters) of surface water from lagoon and settling basins with on-site discharge, backfilling and regrading lagoons and settling basins to promote positive drainage, and on-site disposal of collected sediments and asbestos on the waste piles; implementation of slope stability control measures, if deemed necessary after testing; installation of gabions or riprap to prevent scouring action of the Wissahickon Creek on the waste piles; runoff collection and treatment; preparation of a contingency plan; and access restrictions. The estimated capital cost for this remedial action is \$5,135,000. (Lantz-PTT)

HEALTH ASSESSMENT FOR LAUREL PARK LANDFILL, NAUGATUCK, CONNECTICUT.

Agency for Toxic Substances and Disease Registry, Atlanta, GA. Available from the National Technical Information

### Group 5G-Water Quality Control

Service, Springfield, VA 22161, as PB90-135997. Price codes: A03 in paper copy, A01 in microfiche. CERCLIS No. CTD980521165, December 4,

Descriptors: \*Cleanup operations, \*Connecticut, \*Groundwater pollution, \*Laurel Park Landfill, \*Naugatuck, \*Path of pollutants, \*Public health, Arsenic, Benzene, Chromium, Dichloroethanes, Monitoring, Nitrosodiphenylamine, Site remediation. Soil contamination

The EPA, Region 1, submitted the Endangerment Assessment Report and Remedial Investigation Report for the Laurel Park Landfill, a National Priority List site, to the Agency for Toxic Substances and Disease Registry for review. Based on the information provided, additional monitoring data is needed to determine the extent and degree of contamination in order to properly assess endangerment of public health. However the current germent of public health. However the current maximum contaminant levels found in on-site soil and leachate (i.e., arsenic, chromium, 1,2-dichlor-oethane, benzene, 1,2-dichloroethylene, n-nitroso-diphenylamine, 2,4-dichlorophenol) pose a poten-tial public threat. Therefore public access to the contaminated areas should be restricted. (Author's abstract)

REGIONAL GROUND-WATER QUALITY CHARACTERIZATION OF THE ROCKFORD

AREA, WINNEBAGO COUNTY, ILLINOIS.
Illinois State Water Survey Div., Champaign.
Ground-Water Section.

H. A. Wehrmann, T. R. Holm, L. P. Le Seur, C. D. Curtiss, and A. N. Stecyk.

Available from the National Technical Information

Avanaote from the National Technical Information Service, Springfield, VA 22161, as PB89-197115. Price codes: A06 in paper copy, A01 in microfiche. Report No. HWRIC RR-027, September 1988. 124 p. 10 tab, 62 ref, 6 append.

Descriptors: \*Groundwater pollution, \*Groundwater quality, \*Illinois, \*Monitoring, \*Rockford, \*Volatile organic compounds, Monitoring wells,

An investigation was conducted to determine if regional groundwater contamination, principally by volatile organic compounds (VOCs), has occurred in the Rockford, Illinois area. A number of investigations conducted by local and state agencies have documented the presence of VOCs in the groundwater at several locations in or near the city of Rockford. An estimated 300 wells, including 16 public water supply wells, have been affected by the presence of organic compounds in over 20 ces of groundwater contamination in Winn bago County documented since 1970. Despite the fact that several wells were found to contain VOCs, the preponderance of information collected during this study shows that regional contamina-tion of groundwater in the Rockford area has not occurred. Much of the groundwater used by the residents and industry in the Rockford area was found to be of satisfactory quality with regard to VOCs and selected trace metals. (Author's ab-W91-10265

SUPERFUND RECORD OF DECISION (EPA REGION 3) TYSON'S DUMP SITE, PA.

MEGION 3) TYSON'S DUMP SITE, PA.
Environmental Protection Agency, Washington,
DC. Office of Emergency and Remedial Response.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-225536.
Price codes: A05 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R08-88/068, September
1968. 80p, 4 fig, 4 tab, append.

Descriptors: \*Cleanup operations, \*Pennsylvania, \*Site remediation, \*Superfund, \*Tysons Dump, \*Water pollution sources, Air stripping, Backfilling, Costs, Granular activated carbon, Groundwater pollution, Monitoring, Organic compounds, Pumping, Revegetation, Schuylkill River, Toluene, Trichloropropane, Volatile organic compounds, Waste disposal, Waste lagoons, Xylenes.

The Tyson's Dump site is located in Upper Merion Township, Montgomery County, Pennsylvania. The site is an abandoned septic and chemical waste The site is an abandoned septic and chemical waste disposal facility on a four acre plot bordered on the east and west by unnamed tributaries of the Schuylkill River. During its period of operation from 1962-1970 several formerly unlined lagoons were used to dispose of various industrial, municipal and chemical wastes. Spills and overflows reportedly occurred, dispensing contaminants throughout the site which was closed in 1973. The waste lagoons were emptied, backfilled and vegetated and the contents transported from the site. waste agoons were empeted, outside and vege-tated and the contents transported from the site. The primary contaminants of concern affecting the groundwater are VOCs including: 1,2,3-trichloropropane, total xylenes and toluene, as well as other organics. Selected remedial action for this sue in-cludes pumping and treatment of contaminated groundwater from the bedrock aquifer using air groundwater from the bedrock aquifer using air stripping with vapor-phase carbon (VPC) for treat-ment of gaseous emissions and, if necessary, granu-lar activated carbon (GAC) polishing of air stripped water with discharge of treated water to river; off-site incineration of organic-phase conden-sate produced from steam regeneration of vaporsate produced from steam regeneration of vaporphase carbon beds; and groundwater monitoring. The estimate present worth cost for this remedial action is \$6,170,000 with annual operation and maintenance costs of \$424,300, or \$6,910,000 and \$509,900 respectively, if GAC polishing is implemented. (Lantz-PTT) W91,10266. W91-10266

SUPERFUND RECORD OF DECISION, BELVI-DERE LANDFILL, IL.

DERE LANDILLA II.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-225494. Price codes: A04 in paper copy, A01 in microfiche. EPA/ROD/R05-88/069, June 1988. 70p, 3 fig, 4

Descriptors: \*Belvidere Landfill, \*Cleanup operations, \*Groundwater pollution, \*Illinois, \*Site remediation, \*Superfund, \*Water pollution sources, Capping, Costs, Heavy metals, Kishwaukee River, Landfills, Lead, Organic compounds, Polychloriated biphenyls, Polycyclic aromatic hydrocarbons, Revegetation, Soil contamination, Waste containment, Waste disposal ment, Waste disposal.

The Belvidere Landfill (BL), occupying 19.3 acres of the 139-acre site, is located just outside of the city of Belydere, Boone County, Illinois. The site is located within the 100 year old flood plain of the Kishwaukee River, which is adjacent to the site. From 1939-1973 the site was operated as a municipal and industrial landfill. Approximately 790,00 cubic yards of waste were disposed of at the landfill. fill. In 1979, sand and vegetation were applied as a final cover to the site. The primary contaminants of concern affecting the soil and groundwater include: organics, PCBs, PAHs, metals and lead. Selected remedial action for the site includes: RCRA Subtitle C capping over the 19.3-acre land-fill; treatment or containment of PCB contaminated soil; groundwater pump and treatment with discharge to the Kishwaukee River or the city treatment plant; groundwater monitoring; pond and river fish monitoring; installation of an upgraded fence; deed restrictions to control unacceptable on-site activities and construction; and flood control measures to prevent erosion of the cap and landfill contents. The estimated capital cost for this remedial action is \$5,900,000 with annual operating and maintenance costs of \$271,000. (Lantz-PTT) W91-10267

SUPERFUND RECORD SUMMIT NATIONAL, OH. OF DECISION:

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-225908. Price codes: A08 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-88/068, June 1988. 167p, 14 fig, 22 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Ohio, \*Site remediation, \*Summit Na-

tional Site, \*Superfund, \*Water pollution sources, Arsenic, Benzene, Chemical treatment, Chromium, Coal mines, Costs, Excavation, Hazardous wastes, Heavy metals, Incineration, Mine wastes, Monitor-ing, Organic compounds, Pumping, Soil contami-nation, Solvents, Tires, Toluene, Trichloroethene, Waste disposal, Wells, Xylenes.

The 11.5 acre Summit National site is a former coal strip mine in rural Deerfield Township, Portage County, Ohio, approximately 45 miles southeast of Cleveland. In the area immediately surrounding the site there are several residences, two landfills, a cement plant, a rollerskating rink, and a used tire storage lot. There are 9 residential wells within 1000 feet of the site. Summit National Liquid Services operated a solvent recycling and waste disposal facility on the site from 1973-1978. Solvents, paint sludges, phenols, cyanide, arsenic, and other liquid wastes were stored, incinerated, and buried or dumped during site operations. In addition, 900 to 1600 buried drums and 4 buried tanks containing hazardous substances have been identified at the site. The primary contaminants of concern affecting soil, sediments, groundwater, and surface water are VOCs including: benzene, toluene, TCE and xylenes, other organics including phenols, PAHs and PCBs, and metals including arsenic and chromium. Selected remedial action for this site in-cludes: excavation and on-site incineration of approximately 32,000 cu yds of contaminated soil as sediments and the contents of approximately 1600 buried drums and 4 tanks, with disposal of incinerator residuals in an on-site RCRA landfill; groundator residuals in an on-site KCRA landili; ground-water pump and treatment and on-site surfaces water treatment using precipitation, flocculation, coagulation, oil and water separation, filtration, and carbon adsorption, and discharge of treated water to downgradient surface water; groundwater and surface water monitoring; installation of a RCRA cap over the site and residence relocation. The estimated present worth cost for this site is The estimated present worth cost for this site is \$25,000,000 with annual operating and maintenance costs of \$1,132,250. (Lantz PTT) W91-10268

SUPERFUND RECORD OF DECISION: LIBBY GROUND WATER, MT.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229504. Price codes: A07 in paper copy, A01 in microfiche. Report No. EPA/ROD/R08-89/022, December Report No. EPA/ROD/RO 1988. 132p, 8 fig, 19 tab, 8 ref.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Libby Ground Water Contamination Site, \*Montana, \*Site remediation, \*Superfund, \*Water pollution sources, Aquifers, Benzenes, Biodegradation, Biological treatment, Costs, Creosote, Dioxins, Excavation, Industrial wastewater, Kootenai River, Libby Creek, Polycyclic aromatic hy-drocarbons, Sediment contamination, Soil contami-nation, Volatile organic compounds, Waste con-tainment, Waste disposal, Wood preservatives.

The Libby Groundwater Contamination site (also known as the Champion Mill site or the Libby Pesticide site) is located on the Champion International Corporation lumber and plywood mill in the city of Libby, Lincoln County, Montana. Champion is the third owner of the facility which has been in operation since 1946. The area around the site in operation since 1946. The area around the site includes residential areas and businesses. The site is bordered on the west by Flower Creek, and on the east by Libby Creek, and on the north by the Kootenai River. Groundwater contamination from the site extends well into the City of Libby. Wood treating fluids and their constituents including creosote and PCP, are the contaminants of concern at the city. the site. They are found in soil and sediments at several different locations, including former waste pits, tank storage areas, and butt dip and treatment sites. The contamination is the result of spent fluids, overflow of treatment tanks, and spills. addition to creosote and PCP, certain carrier fu or oils were used at the site and contributed VOC contaminants. Primary contaminants of concern affecting the soil sediments, and groundwater at the site are VOCs including benzene; other organ-

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ics including dioxin, PAHs (creosote constituents), and PCP; metals including arsenic; and oil. Selected remedial action includes excavation and consolidation of 30,000 cu yds of unsaturated soil and debris in the waste pit area, followed by a two step enhanced biodegradation composed of natural bio-degradation and subsequent transfer to a land treat-ment unit consisting of a 3.5-acre lined treatment cell for land farming and final deposition. Selected remedial action for the upper aquifer includes in remedial action for the upper aquifer includes in situ bioremediation of the upper aquifer which is separate from the process used in the saturated zone of the waste pit area. Remedial action for the lower aquifer includes implementation of a pilot test for the oil-contaminated lower aquifer. Esti-mated present worth cost for this remedial action is \$5,777,000 with annual operating and maintenance of \$670,000 for year 2; \$521,200 for years 3-5; \$232,200 for years 6-8; and \$80,000 for years 9-30. (Lantz-PTC) (Lantz-PTT) W91-10269

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION: EMERGING MANAGEMENT AND POLICY. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Na-

varre, Minnesota, 1988, 235p.

Descriptors: \*Agricultural chemicals, \*Fertilizers, \*Groundwater quality, \*Nonpoint pollution sources, \*Pesticides, \*Policy making, \*Water pollution prevention, \*Water pollution sources, \*Water quality management, Environmental policy, Farm management, Groundwater pollution, Water quality, Water resources management.

Groundwater protection and agricultural chemicals are discussed, with special attention to policy and management objectives. The use of over one and management objectives. The use of over one billion pounds of pesticides and millions of tons of nitrogen fertilizers per year in the United States represents a very high potential for groundwater contamination. The detection of increasing amounts of agricultural chemicals in groundwater supplies across the country has led to a social mistrust of the water supply and a mounting political pressure for preventive action. Modeling, Best Management Practices, Integrated Pest Management, education and incentives are strategies currently in use to provide cost-effective and environmentally safe pest management and nitrogen manmentally safe pest management and nitrogen manrently in use to provide cost-effective and environ-mentally safe pest management and nitrogen man-agement programs. Emerging federal policy is being shaped by the Environmental Protection Agency, the Department of Agriculture and feder-al legislators. State and local policy and initiatives include Iowa's 1987 Groundwater Protection Act and the Land Stewardship Project of the midwest. Seventeen papers on various aspects of agrichemicals and groundwater conference. (See W91-10389 thru W91-10405) (MacKeen-PTT) W91-10388

AGRICHEMICALS AND GROUNDWATER: WHAT DO WE KNOW.

Congressional J. E. Blodgett. ssional Research Service, Washington, DC.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Pro-ceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 19-26.

Descriptors: \*Agricultural chemicals, \*Fertilizers, Descriptors: \*Agricultural chemicals, \*Pertilizers, "Groundwater pollution, \*Nonpoint sources, \*Pes-ticides, \*Regulations, \*Water pollution prevention, \*Water pollution sources, \*Water quality, Federal jurisdiction, Groundwater quality, Leaching, Policy making, State jurisdiction, Water quality

A review of agrichemicals and groundwater quality is presented. Detection of pesticide residues in groundwater has led to regulatory responses in a number of states. Nationally, the use of nitrogen fertilizers has levelled off since 1980 and use of restrictions have been presented from 1982 although the processing the process of the p retrainzers has reveiled off since 1982, although the particular compounds used have changed over time. Field use is a major source by which agrichemicals can contaminate groundwater and has been identified as the source of residues of 17 pesticides

found in groundwater of 23 states. Surveys in Iowa show that 10 to 20% of household wells exceed the drinking water standard for nitrates (10 mg N/L) Variables which affect leaching of agrichemicals include water solubility, volatility, soil adsorption, and soil dissipation. Site conditions which are important for potential agrichemical leaching include soil composition, soil physical properties, depth to groundwater, soil and groundwater temperature and pH, and precipitation and groundwater recharge patterns. Farming practices, agrichemical use procedures, and irrigation practices are agronomic variables which affect leaching of agrichemicals into groundwater. Best management procemicals into groundwater. Best management procedures (BMPs) for the use of agrichemicals are being developed based on research findings from specific sites. Methods used to protect groundwaters. er quality are: (1) bans, either national or local; (2) command and control regulations; (3) zoning and command and control regulations; (3) zoning and land use restrictions; (4) economic incentives and disincentives; and (5) voluntary BMPs. It is concluded that programs for protecting groundwater from agrichemical pollution are fragmented at the federal level, and that the states are playing a leading role in program development. (See also W91-10488) (MacKeen-PTT) W91-10389

FACING THE DILEMMA: WHERE DO WE GO FROM HERE.

IOWA DEPT. of Natural Resources, Des Moines. G. R. Hallberg. IN: Agricultural Chemicals and Groundwater Pro-

tection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 43-51.

Descriptors: \*Agricultural chemicals, \*Fertilizers, \*Groundwater pollution, \*Groundwater quality, \*Nonpoint pollution sources, \*Pesticides, \*Regula-tions, \*Water pollution prevention, \*Water quality, Farm management, Nitrates, Policy making, Public health, Water quality management.

The impact of agricultural chemicals on groundwater adds a new scale of complexity to the tradi-tional concerns with agricultural nonpoint source problems. Studies have shown that agriculture is a major contributor to nitrate contamination of groundwater and surface waters, particularly on he regional scale. Technical aspects of the prob-m include the need for understanding the preferlem include the need for understanding the preferential flow of water and chemicals through materials and the diversity of pesticides as a class of compounds. Public perception of the risks of groundwater contaminated by agricultural chemicals is confused by different risk assessments proposed by different interest groups. It is recommended that farm management practices that will balance the need for efficient and profutable crop production and groundwater protection be develproduction and groundwater protection be devel-oped. Studies have concluded that an implementaoped. Studies have concluded that an implementa-tion plan that provides prevention of groundwater contamination is preferred to mitigation after the fact, which is sometimes impossible. To resolve the many long-term prob

AGRICULTURE, THE ENVIRONMENT, AND LEACHING.

IN: Agricultural Chemicals and Groundwater Pro-In: Agricultura Chemicais and Groundwater Pro-tection: Emerging Management and Policy. Pro-ceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Na-varre, Minnesota. 1988. p 55-57.

Descriptors: \*Agricultural chemicals, \*Fertilizers, Descriptors: "Agricultural relements," Fettilizers, "Groundwater pollution, "Groundwater quality, "Leaching, "Path of pollutants, "Pesticides, "Water pollution prevention, "Water quality, Agri-cultural practices, Evaporation, Farm manage-ment, Policy making, Rainfall, Soil characteristics, Water quality management.

Factors linking agricultural practices and environ-mental conditions with leaching of agricultural

chemicals include: rainfall intensity, amount and distribution; temperature; and evaporation. Soil conditions, including texture, permeability, and organic matter content, are key factors in determining the leaching potential at any location. Management factors which may affect leaching are crop type, soil drainage, cropping and tillage history, and rate and method of application. Assessment of potential leaching requires evaluation of the area, operation, product, and total package. One of the most rapidly expanding areas of agricultural research is the development of tools for determining the right fit of the various factors. Balancing environmental, management, and chemical parameters will help to insure an environmentally safe oper-ation. (See also W91-10488) (MacKeen-PTT) W91-10392

ROLE OF MODELING IN DEVELOPING COST-EFFECTIVE AND ENVIRONMENTAL-LY SAFE PEST MANAGEMENT PROGRAMS. Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering. C. A. Shoemaker

IN: Agricultural Chemicals and Groundwater Pro-In: Agricultural Chemicas and Ordina Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 59-68. 1 tab, 6 ref.

Descriptors: \*Agricultural chemicals, \*Cost analy-Descriptors: "Agricultural cnemicals, "Cost analysis, "Groundwater pollution, "Groundwater quality, "Model studies, "Path of pollutants, "Pesticides, "Water pollution prevention, "Water quality, Beetles, Economic aspects, Farm management, Leaching, Long Island, New York, Pests, Policy making, Potatoes, Water quality management.

In applications to groundwater pollution, models attempt to describe the movement of pesticide though the soil and the chemical and biological transformations that occur during the movement. Models are also used to help develop pest control policies that are responsive to fluctuations in pest densities and weather conditions. Three interacting models have been used to develop pest control practices for the Colorado potato beetle on Long Island. PRISM was used to describe the movement Island. PRISM was used to escribe the movement of pesticide through the unsaturated zone into groundwater. A weather simulator program used historical weather data to generate typical weather patterns for the local area of Long Island. The third model used in the analysis was a simulation model of the Colorado potato beetle. Preliminary simulation results indicated that cost-effective and environmentally sound policies involve the use of economic thresholds with the pesticide vydate. The economic threshold is defined as the minimum density of pests for which the cost of the pesticide definity of pests for which the cost of the pesticide application is less than the economic value of the crop yield loss prevented by the application of the pesticide. Results also indicated that vydate applications are not necessarily preferable to aldicarb cations are not necessarily preferable to addicare applications unless an economic threshold policy is implemented. A major benefit of the use of models is the ability to evaluate pest control alternatives over a range of conditions. (See also W91-10488) (MacKeen-PTT) W91-10393

ROLE OF BEST MANAGEMENT PRACTICES. South National Technical Service Center, Soil Conservation Service, Fort Worth, Texas. J. P. Burt.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 69-78.

Descriptors: \*Agricultural chemicals, \*Best management practices, \*Groundwater pollution, \*Groundwater quality, \*Nonpoint pollution sources, \*Regulations, \*Water pollution prevenion, \*Water quality management, Farm management, Leaching, Policy making, Water quality.

As a result of the Clean Water Act, Best Management Practices (BMPs) were developed in the 1970s to minimize agricultural pollution of water

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from nonpoint sources (NPS). The erosion control and animal waste management practices in the National Handbook of Conservation Practices published by the Soil Conservation Service were readily accepted for BMPs. Similar practices were developed for forestry. Integrated Pest Management served as a BMP to reduce pesticide usage. Two major flaws of the process were: (1) the actual surface water quality problems and anticipated effects were often not defined, and (2) groundwater was not considered. BMPs in groundwater sensitive areas should be tailored to the local soil, climate and geological conditions. Recommendations for BMP development include: monthly meeting of all county USDA agencies; meeting of agencies at the state level; and targeting funds and staff time to solve recognized problems. It is concluded that, while some progress has been made in reducing NPS pollution of surface waters, considerable work on BMPs for the reduction of NPS loads to groundwater is required. BMPs for groundwater protection will rely heavily on management practices rather than structural practices. (See also W91-10488) (MacKeen-PTT)

### ROLE OF EDUCATION AND INCENTIVES,

Clemson Univ., SC. P. Mac Horton.

P. Mac Horton.
IIN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 79-82.

Descriptors: \*Agricultural chemicals, \*Education, \*Groundwater quality, \*Water pollution prevention, \*Water quality management, Economic impact, Farm management, Groundwater pollution, Policy making, Water quality.

The Cooperative Extension Service develops practical, research-based programs to educate the agricultural community about the use of agricultural chemicals. Programs are presented in farmer meetings, publications, news articles, field days, and onsite demonstrations. Positive incentives to convince farmers to protect groundwater from agrichemical contamination include the following: personal health of farmer and his family; long-term productivity of the land; and economic benefits. Negative incentives may arise from pressure from the non-farm public, in particular the news media, and regulatory guidelines. An educational program must change knowledge, attitudes, and behavior to be effective. A key component of a successful program is that it must be economically acceptable. Commitment of resources on a national level to a more comprehensive Integrated Crop Production, Protection and Management System is recommended. (See also W91-10488) (MacKeen-PTT) W91-10395

#### DEVELOPMENT OF A NITROGEN MANAGE-MENT MODEL: POTENTIAL FOR SITE-SPE-CIFIC GROUNDWATER PROTECTION, L. G. Bundy.

L. U. Bundy.

This Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 111-116. 2 fig, 1 tab, 4

Descriptors: \*Agricultural chemicals, \*Fertilizers, \*Groundwater pollution, \*Groundwater quality, \*Model studies, \*Nitrogen, \*Water pollution prevention, Agriculture, Corn, Farm management, Leaching, Policy making, Water quality, Water quality management, Wisconsin.

A nitrogen management model for use in crop production was developed. The Wisconsin nitrogen management model is interactive and requires user input of site-specific information to produce a site-specific nitrogen recommendation. A database consisting of results from over 60 nitrogen response experiments with corn conducted on major soil types throughout Wisconsin is utilized to estimate model parameters for calculation of corn nitrogen fertilizer recommendations. The model is

intended to provide nitrogen rate and management recommendations for corn in individual fields with relatively uniform soil characteristics and past management practices. User inputs required for model operation are: soil series name; corn yield goal; crop history during the past 2 yr; type, amount, and analysis of manure applied during the past 3 yr; and the user's nitrogen management plans. Use of the model is expected to improve the accuracy of nitrogen recommendations for corn production. In addition, a site-specific assessment of the risks of nitrate additions to groundwater is provided where soil and climatic conditions favor nitrogen loss through leaching. (See also W91-10488) (MacKeen-PTT)

### EFFECTIVE NITROGEN MANAGEMENT: CONSIDERATIONS FOR GROWERS.

G. W. Randall.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 117-123. 5 tab, 4 ref.

Descriptors: \*Agricultural chemicals, \*Farm management, \*Fertilizers, \*Groundwater pollution, \*Groundwater quality, \*Nitrogen, \*Water pollution prevention, Agriculture, Best management practices, Leaching, Nitrates, Water quality management.

Grower considerations for best nitrogen management practices are reviewed. Nitrogen management needs to reflect the productive capacity of the soil because a more productive soil often requires higher N rates for optimum efficiency. The grower and the N supplier both need to consider the management ability of the grower to maximize N efficiency. Other factors in N management include previous crop history, placement and timing of N application, residual nitrate soil test level, other nutrient sources, nitrogen costs, and nitrogen risk/cost ratios. To reduce the effects of N on groundwater, greatest progress can be gained by fine-tuning the rate of N application, regardless of N source. This requires giving credit for the N content in the manure application, repardless of not source. This requires giving credit for the N content in the manure application from N fixed from previous crops. Coupling proper application rates with improved application techniques, residual soil nitrate, and nitrification inhibitors will minimize the environmental effects while optimizing the returns from nitrogen applications. (See also W91-10488) (MacKeen-PTT)

# AGRICULTURAL MANAGEMENT PRACTICES TO MINIMIZE GROUNDWATER CONTAMINATION AND A SITE-SPECIFIC FARM ASSESSMENT PROCESS.

G. W. Jackson.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 125-131.

Descriptors: \*Agricultural chemicals, \*Farm management, \*Fertilizers, \*Groundwater pollution, \*Groundwater quality, \*Pesticides, \*Water pollution prevention, Agriculture, Evaluation, Leaching, Water quality, Water quality management.

Agricultural management practices to minimize groundwater contamination are discussed. A number of strategies may reduce the potential for groundwater pollution: (1) reduction of amounts of pesticides and fertilizers applied; (2) reduction of agricultural chemical concentrations in soil during spring and fall; (3) increase in efficiency of crop use of agricultural chemicals; (4) use of pesticides which have low leaching potentials; (5) modification of water infiltration, percolation and/or groundwater movement; and (6) improvement of chemical handling and disposal practices. A proposed Farm Assessment System would involve evaluation of: (1) existing drinking water quality; (2) soils, superficial geologic, hydrologic and bedrock characteristics; and (3) existing farm structures and management practices. The development

of the assessment program would require establishment of evaluation criteria for each structure and management practice and a weighted scale to correlate physical site vulnerability ratings. To be effective in preventing and correcting identified problems, technical and financial assistance to modify structures and educational and technical assistance to improve management practices would also be needed. (See also W91-10488) (MacKeen-PTT)
W91-10398

### EPA'S PESTICIDES IN GROUND WATER STRATEGY.

V. J. Kimm, and R. Barles.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 135-145.

Descriptors: \*Administrative agencies, \*Agricultural chemicals, \*Environmental policy, 'Groundwater pollution, \*Groundwater quality, \*Pesticides, \*Policy making, \*Regulations, \*Water pollution, prevention, Administrative regulations, Farm management, Federal jurisdiction, Legal aspects, Public policy, Water quality, Water quality management, Water resources management.

The strategy of EPA for reducing pesticide contamination in groundwater is reviewed. Key agency measures for groundwater protection include screening new pesticides for groundwater contamination potential, special review of several existing pesticides, requirement of groundwater monitoring studies by registrants, placement of some pesticides into the restricted use category, national survey of pesticides in drinking water wells, development of maximum contaminant levels for several pesticides, support of states under the Clean Water Act, and establishment of the Well-Head Protection Program. A long-term strategy for management of pesticides to protect groundwater resources has been developed by EPA. The strategy focuses on prevention of groundwater contamination rather than treatment of contaminated water. EPA will recognize differences in the use and value of groundwater resources when establishing protection measures. Risks posed by a pesticide are considered 'reasonable' if the benefits of use outweigh the potential impacts on the environment or human health. A combination of EPA-directed and state-directed measures will include uniform national measures, site conditional measures, and area specified measures. User/registrant responsibilities will include education, groundwater monitoring, and product stewardship. (See also W91-10488) (MacKeen-PTT)

# U.S. DEPARTMENT OF AGRICULTURE'S GROUNDWATER POLICY PROCESS. F. Swader.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 147-154.

Descriptors: \*Administrative agencies, \*Agricultural chemicals, \*Agriculture, \*Groundwater pollution, \*Groundwater quality, \*Policy making, \*Water pollution prevention, Administrative regulations, Environmental policy, Federal jurisdiction, Water quality, Water quality management, Water resources management.

The USDA Groundwater Policy Task Group has been charged with drafting a groundwater policy statement for the agency. The Groundwater Policy Task Group surveyed the individual agencies of the USDA to determine the extent, scope, and status of their groundwater programs. The Agricultural Research Service has developed a strategic program for research on groundwater quality management. The Extension Service has developed a policy statement recommending new proped a policy statement recommending new pro-

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Water Quality Control—Group 5G

grams in four areas of groundwater: (1) nature of water resources, water quality, and protection or treatment options; (2) impacts of chemicals on groundwater quality; (3) options of local governments for addressing groundwater quality, land use and chemical use issues; and (4) public education about water conservation. The Soil Conservation Service provides assistance for surface and groundwater quality protection to private land and water users, to soil and water conservation districts, and to other government agencies. Other USDA agencies such as the Agricultural Stabilization and Conservation Service, the Cooperative State Research Service, the Economic Research Service, the Farmers Home Administration and the Federal Crop Insurance Corporation, while lacking explicit groundwater policy, help to protect groundwater resources. The USDA is currently in the final stages of adopting a formal groundwater quality to reflect the importance of groundwater quality to reflect the importance of groundwater quality to the scene water in the final stages of adopting a formal groundwater quality to reflect the importance of groundwater quality to the scene water in the final stages of adopting a formal groundwater quality to reflect the importance of groundwater quality to the scene water the service of the scene water the service of the servic reflect the importance of groundwater quality to the agency mission. (See also W91-10488) (MacK-een-PTT) W91-10400

#### UPDATE AND REVIEW OF FEDERAL LEGIS-LATION.

Environmental Policy Inst., Washington, DC. V. M. Smith.

V. M. Smith. In: Agricultural Chemicals and Groundwater Pro-tection: Emerging Management and Policy. Pro-ceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 155-160.

Descriptors: \*Agricultural chemicals, \*Federal jurisdiction, \*Groundwater pollution, \*Groundwater quality, \*Legislation, \*Water pollution prevention, Administrative agencies, Administrative regulations, Drinking water, Environmental policy, Legal aspects, Pesticides, Policy making, Water quality, Water quality management, Water resources management

A review of federal legislation on the groundwater quality issue showed that numerous pieces of groundwater legislation were introduced in the 100th Congress. In particular, three bills amending 100th Congress. In particular, three bills amending the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) deal with groundwater contamination: H.R. 3174, and S. 1419, each named the Groundwater Safety Act of 1987, and H.R. 2463, a reauthorization of all of FIFRA. All three bills direct EPA to examine what pesticides are bills direct EPA to examine what pesticides are likely to leach into groundwater and require the registrant of the pesticide to share information on detection with EPA. H.R. 3174 and S. 1419 also strengthen EPA's ability to require monitoring by the registrant. All three bills use water quality standards as triggers for response to contamination. The EPA is to set a groundwater residue guidance level (GRGL) based on the level of pesticide at which there would be no adverse effect on human health. Once GRGLs are established, detection of certain percentages of those levels triggers a range neath. Once OROLS are established, detection or certain percentages of those levels triggers a range of responses including: (1) amend pesticide's registration; (2) inform state in question; or (3) take direct site-specific action. H.R. 3174 and S. 1419 protect all potential sources of drinking water, while H.R. 2463 appears to apply only to sources currently in use. The cost-benefit weighting currently in use. The cost-benefit weighting scheme of FIFRA does not allow for prevention of risks until there is a convincing body of data that shows the risks cuttweigh benefits. (See also W91-1048) (MacKeen-PTT) W91-10401

### OVERVIEW OF INNOVATIVE STATE POLICY

National Conference of State Legislatures, Denver, CO.

. Morandi

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 163-166.

Descriptors: \*Agricultural chemicals, \*Ground-water pollution, \*Groundwater quality, \*Legislation, \*Policy making, \*State jurisdiction, \*Water pollution prevention, Environmental policy, Legal

aspects, Water quality, Water quality management, Water resources management.

States are taking the initiative in developing States are taking the initiative in developing groundwater protection policy, especially as it relates to managing agricultural chemicals. In a 1985 survey of legislation, the National Conference of State Legislatures found that 24 states had enacted groundwater protection statutes. The largest plurality of states, 14, passed measures addressing agricultural chemicals. Preliminary results from a 1986-87 survey confirm the interest in pesticides legislation. Groundwater protection policies designed to control agricultural contamination generally take one of two forms: (1) comprehensive groundwater strategies that incorporate agricultural contaminations. ally take one of two forms: (1) comprehensive groundwater strategies that incorporate agricultural chemicals into the same regulatory framework as other pollutants; and (2) specific legislation aimed exclusively at protecting groundwater quality from farming activities. Wisconsin and Arizona are examples of state programs that use the same regulatory framework for all pollutants; California, Iowa, and Nebraska have enacted specific statutes for agricultural chemicals. In each instance, legislation was exential in formulating extended. tion was essential in formulating state policy. (See also W91-10488) (Author's abstract) W91-10402

## IOWA'S 1987 GROUNDWATER PROTECTION ACT: PURPOSE AND PROCESS, D.W. Iohannes

IN: Agricultural Chemicals and Groundwater Pro-In: Agricultural chemicas and Groundwater Fro-tection: Emerging Management and Policy. Pro-ceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Na-varre, Minnesota. 1988. p 167-170.

Descriptors: \*Agricultural chemicals, \*Groundwater pollution, "Groundwater protection, "Groundwater quality, "Iowa, "Legislation, "Policy making, "State jurisdiction, "Water pollu-tion prevention, Education, Environmental policy, Legal aspects, Water quality, Water quality man-agement, Water resources management.

The major components of Iowa's 1987 Ground-water Protection Act (GPA) fall into four major categories: education, research, demonstration, and regulation. All state and local agencies are required regulation. All state and local agencies are required to consider groundwater protection policies in administration of their programs. Education requirements of the GPA include dissemination of information on groundwater contamination to the public, classes for pesticide applicators, notice to adjoining urban properties of pesticide application, described by the containing howeshold labelling of store shelves containing household hazardous material, community toxic cleanup days, and disclosure of location of wells and waste disposal sites during all transfers of properties. The GPA establishes two new research centers. The Leopold Center for Sustainable Agriculture at Iowa State University conducts and sponsors re-search to identify and reduce negative environmental and socioeconomic impacts of agricultural practices. The Center for Health Effects of Enviromental Contamination at the University of Iowa is charged with determining the levels of environmental contamination which can be specifically associated with human health effects. Regulations of the contamination which cally associated with human health effects. Regulations imposed by the GPA apply to landfill operators, abandoned wells and new well drilling, underground storage tanks, and all dumping on land. An important component of Iowa's GPA is that, except for \$17.5 million in oil overcharge funds, all of the mean than \$60 million to be acceptant, all of the more than \$60 million to be spent over the next 5 yr will come from fees on those products next 5 yr will come from tees on those products which threaten to pollute groundwater. The development of the legislation took 3 to 4 years and involved contributions from the Department of Natural Resources, dedicated researchers, legislators, and a determined press. (See also W91-10488) (MacKeen-PTT)
W91-10403

## FORCES DRIVING STATE GROUNDWATER PROTECTION ACTIONS,

J. Carlson.

J. Carlson.
IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Na-

varre, Minnesota. 1988. p 171-174.

Descriptors: \*Agricultural chemicals, \*Ground-water pollution, \*Groundwater quality, \*Legisla-tion, \*State jurisdiction, \*Water pollution prevention, Administrative agencies, Environmental policy, Governmental interrelations, Groundwater protection, Legal aspects, Massachusetts, Pesticles, Policy making, Regulations, Water quality, Water quality management, Water resources management, water policy management, water policy management, water policy processes and provided the provided provided the provided provide

Over the past few years state agencies have been placed under increasing pressure to respond to concerns related to groundwater contamination from agricultural chemicals. Three factors influfrom agricultural chemicals. Three factors influence state regulatory action on groundwater contamination: (1) public perception, (2) scientific limitations, and (3) political reality. There is a growing public perception that all pesticides are bad and that no amount of residue in drinking water is safe. The scientific prediction of leaching behavior of a given pesticide under the multitude of pertinent environmental conditions is still not possible with certainty. Likewise, debate persists over the long-term risk posed by exposure to low levels of pestiterm risk posed by exposure to low levels of pesti-cides. The potential costs of remedial action for contaminated groundwater are unknown but prob-ably very high. The length of time required by the federal government to develop policy or imp ment a regulatory decision also creates increas pressure on state regulatory programs. The politi-cal reality is that state governments are under enormous pressure to respond to groundwater issues. In Massachusetts, these factors have most recently contributed to a decision by the Pesticide Board Subcommittee to classify nine pesticides as restricted use and to cancel the registration of another. It is concluded that the long-term success of efforts to prevent groundwater contamination will depend upon coordination of overlapping state and federal laws. (See also W91-10488) (MacKeen-PTT) W91-10404

## BUILDING COMMUNITY SUPPORT FOR GROUNDWATER PROTECTION.

D. Nopar.

IN: Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy. Proceedings of a conference held in St. Paul, MN, October 22-23, 1987. Freshwater Foundation, Navarre, Minnesota. 1988. p 175-179.

Descriptors: \*Agricultural chemicals, \*Agricul-Descriptors: "Agricultura chemicas, Agriculture, "Environmental protection, "Farm management, "Groundwater pollution, "Groundwater quality, "Water pollution prevention, Education, Environmental policy, Erosion control, Minnesota, Organizations, Pesticides, Public policy, Soil conservation, Water quality, Water quality management.

The Land Stewardship Project is a private, non-profit organization, founded in 1982, that works profit organization, founded in 1982, that works with farmers and conservation-minded rural citizens throughout the upper midwest. Winona County, Minnesota, was the site of a model program for stewardship agriculture. Educational programs included: township neighborhood meetings attended by more than a third of the farmers in the county; annual breakfast meeting and conservation tour; soil conservation and land use history program, in collaboration with the Winona County Historical Society; and planting by local school children of more than 20,000 tree seedlings on highly erodible land. Direct action campaigns and enturen or more than 20,000 tree seedlings on highly erolible land. Direct action campaigns and public policy debate were used to approach issues such as neglect of established conservation stand-ards by absentee landowners. The passage of a county level soil erosion ordinance that would set penalties for expressive soil loss was accord. The county level soil erosion ordinance that would set penalties for excessive soil loss was sought. The Winona Model County program also served to raise public awareness and to nurture a community land ethic. A 3-year project will conduct small-scale experiments aimed at reduction of the use of agricultural chemicals. Topics include: using legagricultural enemicals. Topics include: using reg-umes and manure as nitrogen sources; using winter cover crops; growing alternative forage crops such as milage, barley, or triticale; using the New Zea-land style of intensive rotational grazing; and using

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ridge-tillage. Basic principals of Land Stewardship are reduction of agricultural chemical usage with a long-term goal of eliminating pesticides, and promotion of small-scale farming operations. (See also W91-10488) (MacKeen-PTT) W91-10405

### POLLUTION: CAUSES, EFFECTS AND CON-

For primary bibliographic entry see Field 5B. W91-10406

# CHEMICAL POLLUTION OF THE AQUATIC ENVIRONMENT BY PRIORITY POLLUTANTS AND ITS CONTROL. Water Research Centre, Medmenham (England). Medmenham Lab.

For primary bibliographic entry see Field 5B. W91-10407

#### LEGAL CONTROL OF POLLUTION.

Imperial Coll. of Science and Technology, London (England). Centre for Environmental Technology. For primary bibliographic entry see Field 6E. W91-10418

# CONTROL OF INDUSTRIAL POLLUTION, RTZ Limited, York House, Bond Street, Bristol BSI 3PE, England.

IN: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 297-308.

Descriptors: \*Air pollution control, \*England, \*Environmental protection, \*Environmental quality, \*Industrial wastes, \*Waste disposal, \*Water pollution control, Best management practices, Carcinogens, Effluents, Emission control, Enforcement, Regulations.

Some degree of disposal of industrial wastes must be permitted, but this must be limited such that the natural absorptive capacity of the environment, and degradation processes, prevent a cumulative reduction in environmental quality. An outline of British control procedures is presented for air pollution, liquid effluent control, solid waste disposal, nution, injust entuent control, sond waste ansposar, integrated pollution control, employee protection, and carcinogens. In the control of pollution from existing manufacturing operations industry in the United Kingdom will seek a system which: (1) is based on criteria which are scientifically sound; (2) allows consultation between the control authorities and the controlled to ensure a workable scheme that achieves the intended result; (3) puts emphasis that achieves the intended result; (3) puts emphasis on field inspection and enforcement by an adequately resourced and technically capable staff; and (4) treats the environment as an integrated whole, where necessary applying the 'best practicable environmental option' to the disposal of wastes and emissions which inevitably arise. (See also W91-10406) (White-Reimer-PTT) W91-10419

PESTICIDES AND GROUNDWATER: A HEALTH CONCERN FOR THE MIDWEST. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnester 1987 138e. sota. 1987. 338p.

Descriptors: \*Agricultural chemicals, \*Ground-water pollution, \*Nonpoint pollution sources, \*Pesticides, \*Public health, \*Water pollution con-trol, \*Water pollution sources, Administrative reg-ulations, Environmental policy, Population expo-sure, Risk assessment, Water pollution prevention, Water online Water quality.

Evidence of significant pesticide contamination is seen in groundwater in the Midwest although the precise magnitude of the national problem remains to be determined. The U.S. Environmental Protecto be determined. The U.S. Environmental Flow-tion Agency (EPA) has a vital interest in this issue. EPA regulates pesticides as they are used, drinking the consumed and waste disposal water quality as it is consumed, and waste dispos

practices (including spent pesticides) and has a direct responsibility, working with the states, to take whatever action is necessary to prevent further contamination of groundwater and deal with past contamination. The assessment of public health risk of pesticides in groundwater relies upon epidemiological data and animal models. Health risks under study include cancer and immune function alterations. To minimize health risks and protect groundwater quellity, a complication of solution alterations. To minimize health risks and protect groundwater quality, a combination of solutions will be necessary: more extensive monitoring of groundwater, expansion of epidemiological studies, integrated pest management programs, and legislative and regulatory initiatives at the federal, state, and local levels. (See W90-10424 thru W90-10444) (MacKeen-PTT) W91-10423

## MIDWEST USE OF PESTICIDES AND CHANGING AGRICULTURAL NEEDS.

Iowa State Univ., Ames. Center for Agricultural and Rural Development. For primary bibliographic entry see Field 5B. W91-10424

### PESTICIDES AND THE GROUND WATER

CONNECTION.
Environmental Protection Agency, Washington,
DC. Office of Pesticide Programs.
D. J. Severn.

D.J. severn.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. 29-44. 8 fig, 2 ref.

Descriptors: "Administrative agencies, "Agricultural chemicals, "Environmental protection, "Groundwater pollution, "Pesticides, "Water pollution prevention, Administrative regulations, Environmental policy, Risk assessment, Solute transport, Toxicology, Water quality, Water quality monitoring.

The use of pesticides in the United States is regulated by EPA under the Federal Fungicide and Rodenticide Act (FIFRA). FIFRA allows the registration and use of pesticides only after a large amount of environmental hazard information has been submitted and reviewed. Animal toxicology studies required for pesticide registration include short-term oral, dermal, and inhalation tests, studsnort-term oral, dermal, and inhalation tests, stud-ies on the potential for reproductive and terato-genic effects, and long-term feeding studies. Path-ways for pesticide transport away from the site of application include drift or volatilization, runoff from a sloping field, plant uptake, or downward movement through the soil column. Pesticide deg-radation commonly takes place during all of these processes by photodegradation, biodegradation, oxidation or hydrolysis. Pesticide properties which lead to rapid leaching are high solubility, low degree of soil binding and moderate or high peruegree of son omining and moderate or high per-sistence. Leaching potential is also strongly influ-enced by the soil and weather patterns at the site of use. At least 17 pesticides have been found in groundwater in a total of 23 states as a result of the agricultural use of pesticides. A planned national survey of pesticide in groundwater will monitor both public supply wells and domestic drinking water wells for about 60 pesticides. Counties have been ranked on the basis of pesticide use and vulnerability to groundwater contamination to aid in the selection of sampling sites. EPA goals are to identify pesticides which may cause problems, to design labels and educational materials to minimize the threat to groundwater, and to provide health guidance information in response to individual contamination events. (See also W91-10423) (MacKeen-PTT) W91-10425

# WISCONSIN'S GROUNDWATER MONITOR-ING PROGRAM FOR PESTICIDES. For primary bibliographic entry see Field 5A. W91-10428

## PESTICIDE REGISTRATION AND THE SAFE DRINKING WATER ACT: A FEDERAL PER-

### SPECTIVE FOR HEALTH STANDARD SET-

Environmental Protection Agency, Washington, DC. Office of Drinking Water.

P. A. Fenner-Crisp.

P. A. Fenner-Crisp.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. 233-245. 6 tab.

Descriptors: \*Drinking water, \*Pesticides, \*Public health, \*Safe Drinking Water Act, \*Water pollution control, \*Water quality standards, Administrative regulations, Carcinogens, Federal jurisdiction, Human population, Legislation, Population exposure.

The Safe Drinking Water Act states that primary drinking water regulations are to be published which (1) specify contaminants which may have adverse health effects; (2) set for each contaminant either a Maximum Contaminant Level (MCL) or a reporting requirements and Qublic monitoring/ reporting requirements and public notification. The regulatory approach to setting Maximum Contam-nant Level Goals (MCLOs) consists of three categories, based upon the EPA scheme for classifica-tion of carcinogenic potential. MCLGs for Category I substances (known or probable human car-cinogens) are set at zero, based on the assumption cinogens) are set at zero, based on the assumption that carcinogenicity does not exhibit a threshold. Category II includes those substances for which limited evidence of carcinogenic potential exists from animal data. Selection of MCLGs for this group may be based upon non-carcinogenic endpoints, Reference Dose and Drinking Water Equivalent Level (DWEL), or upon an excess lifetime cancer risk calculation. Category III includes those substances with inadequate or no evidence of carcinogenicity. MCLGs for Category III substances are based upon DWEL. The MCL is derived from the MCLG by evaluating the feasibility of achieving the goal based upon availability of ity of achieving the goal based upon availability of analytical methods and treatment technology, as well as cost of compliance. The Health Advisory weil as cost of compliance. In e Health Advisory Program has been established to assist in assessing potential health consequences of contaminants for which drinking water standards have not been set. Health Advisories are documents which offer drinking water concentrations at which negative health effects would not be expected to occur, as well as technical information on analytical and treatment methods. It is concluded that the Safe Drinking Water Act and its 1986 amendments will have a significant impact on registration of pesticides. (See also W91-10423) (MacKeen-PTT) W91-10435

## CARCINOGENS IN DRINKING WATER AND WATER QUALITY STANDARDS. Centers for Disease Control, Atlanta, GA. Center

for Environmental Health.

V. N. HOIK.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 247-252.

Descriptors: \*Carcinogens, \*Drinking water, \*Population exposure, \*Public health, \*Water quality control, \*Water quality standards, Animal models, Dose-response relationships, Human population, Research priorities, Risk assessment, Water

Many if not most public water supplies in the United States contain chemicals that cause cancer in laboratory animals exposed to high levels. Man-made pollutants in water come from chemicals used in industry, in agriculture, and in the home. While a total absence of carcinogens in water is unrealistic, regulation of water pollution attempts to reduce pollutants to the lowest practical level. Regulating water quality with respect to carcinogens requires an assessment of the risks of expo-sure. A number of assumptions have been used in making a quantitative assessment of cancer risk: (1)

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the zero-threshold assumption, which assigns a finite risk to even very low levels of carcinogen; (2) the assumption that animal data can be applied to humans, using correction factors for weight or body surface area; (3) the assumption that the doscresponse at high dose levels is the same as the relationship at very the low doses found in drinking water; (4) the assumption that the observed concentration of a carcinogen in water is not altered by any treatment at the water plant or at home; (5) the assumption that the exposure level does not change during a full life span; and (6) the assumption that the actual dose-response relationship in humans equals the relationship in the mathematical model used to determine the dose-response in rodents. Research aimed at validating these assumptions is recommended. (See also W91-10423) (MacKeen-PTT) W91-10433) (MacKeen-PTT)

## WISCONSIN'S GROUNDWATER LAW: PUBLIC HEALTH IMPACTS AND ENFORCEMENT.

Wisconsin Dept. of Agriculture, Madison. Trade

and Consumer Protection
O. Ehart.

O. Ehart.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 277-281. 2 tab.

Descriptors: \*Enforcement, \*Environmental law, \*Groundwater pollution, \*Public health, \*Water pollution control, \*Water quality standards, \*Wisconsin, Administrative agencies, Administrative regulations, Fertilizers, Legislation, Pesticides, Population exposure.

Wisconsin's groundwater law, enacted in May 1984, establishes the use of health advisory levels as the standards for enforcement actions. It also establishes preventive action limits as a percentage of enforcement standards. Regulatory agencies involved in the program include the Department of Natural Resources (DNR), the Department of Natural Resources (DNR), the Department of Ferrices (DHSS), and the Department of Agriculture, Trade, and Consumer Protection (DATCP). Under DATCP a rule has been established which details the regulatory program for the prevention and control of groundwater contamination by fertilizer and pesticide substances when that contamination has resulted from, or may be aggravated by, activities subject to the DATCP's regulation. Substance-specific rules have been established for aldicarb. Numerical standards have been established by DNR for 12 pesticide active ingredients and for nitrate. DHSS has proposed standards to DNR for reven pesticides. Monitoring is currently ongoing in Wisconsin to determine the leaching potential of aldicarb, alachor, simazine, atrazine, picloram, and carbofuran under a variety of crop and land use conditions. The Wisconsin program is being financed by general tax money and funds collected directly from the pesticide industry. Enforcement of the program will require improved education of pesticide users, calibration of pesticide application equipment, more detailed record keeping and better incentives. (See also W91-10423) (MacKeen-PTT)

## REDUCING AGRICULTURAL PESTICIDE RESIDUES IN CALIFORNIA GROUND

California Dept. of Food and Agriculture, Sacramento.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 283-291. 1 fig. 2 tab.

Descriptors: \*Agricultural chemicals, \*California, \*Groundwater pollution, \*Pesticides, \*Water pol-

lution control, \*Water quality standards, Administrative agencies, Administrative regulations, Legislation, Pesticide residues, Public health, Water quality monitoring.

The two main components of pesticide regulation by the California Department of Food and Agriculture (CDFA) are risk assessment (evaluation of data) and risk management (regulatory action). Assessing risk involves analyzing hazards to humans and other living things of pesticides on food and in the environment. Risk management measures include denial of registration and restriction of use. The Pesticide Contamination Prevention Act, enacted Jan. 1, 1986, directs CDFA to collect and evaluate environmental fate data for each pesticide registered in California and allows restricted or suspended use of chemicals demonstrated to be groundwater hazards. The Ground Water Protection Plan of CDFA incorporates the results of laboratory studies, well sampling, soil coring, and computer modeling studies to eventually develop 'risk measures' indicating the potential for a pesticide used in agriculture to reach groundwater in designated areas. Data on over 10,000 samples taken from 5,000 wells between 1975-84 indicated that wells in 15 of 26 counties sampled contained pesticide residues. Residues were detected in 39% of samples, and 94% of positive samples contained pesticide residues. Residues were detected in in 1976 of 50 counties asmples contained pesticide residues. Residues were detected in in 1976 have been found in groundwater as a result of legal use, four of which have been suspended or withdrawn from the market, and the remaining four (atrazine, simazine, diuron, and bromacil) have been placed under review by the Pesticide Contamination Prevention Act. (See also W91-10423) (MacKeen-PTT) W91-10439

## CHANGING RESPONSIBILITIES IN THE AGRICULTURAL COMMUNITY.

C. M. Benbrook.

IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 299-308. 1 tab, 7 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Groundwater pollution, \*Pesticides, \*Public participation, \*Water pollution control, Agricultural community, Economic aspects, Environmental policy, Risk assessment, Rural areas, Water pollution prevention.

While the public health significance of very low levels of pesticides in groundwater is unknown, the agricultural community bears responsibility for protecting groundwater from contamination by agricultural chemicals and for communicating possible health risks of groundwater contamination. Educational efforts to advise farmers on the need to follow pesticide labels and to take care in mixing, loading, and disposal operations are simple measures which may greatly reduce the risk faced by farmers and their families. Critical scientific issues in pesticide contamination include: development of risk assessment models; improvement of multi-residue analytical techniques for groundwater screening; the potential for nitrosamines to form in the human gut from triazines and nitrates; clarification of the effects of pesticides in groundwater quality. Ongoing, targeted monitoring of groundwater for pesticides is critical to recognizing trends and to address questions about the effects of specific field conditions. Risk assessment is approached from a risk and benefit standpoint by EPA. EPA data indicate that water-borne exposure now poses as much or more of a risk to humans than dietary exposure. However, a recent EPA decision on alachlor use implies that a one in one million cancer risk from pesticides in groundwater is acceptable. As a powerful political force, the agricultural community should be capable of generating sufficient support to secure new money for water quality-related activities. (See also W91-10423) (MacKeen-PTT)

SOME EXAMPLES OF ES-USDA GROUND-WATER QUALITY PROGRAMS: 'NEW TOOLS FOR LOCAL GOVERNMENT'.

Γ. Halbach.

11. Pasticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 311-318.

Descriptors: \*Administrative agencies, \*Agricultural chemicals, \*Agriculture, \*Education, Groundwater pollution, \*Pesticides, \*Water pollution control, Environmental policy, Groundwater protection, Minnesota, New York, Water pollution prevention, Wisconsin.

In February 1985 the USDA Extension Service (ES-USDA) Committee on Organization and Policy adopted EPA's stated national groundwater protection strategy. The Extension Service concurs with the conclusions of the EPA study on pesticides in groundwater that there is a need for more research about the nature and extent of pesticide contamination of groundwater and related health risks. In its 1988-1992 planning cycle, ES-USDA will encourage states and counties to conduct educational programs to: (1) promote the protection, maintenance, and restoration of groundwater quality; (2) provide the opportunity for public involvement in decisions related to groundwater quality; (3) emphasize positive voluntary actions by landowners to minimize and prevent groundwater quality problems; and (4) assist landowners and land users to develop resource management systems which include groundwater quality consideration. ES-USDA funded programs in Minnesota include development of a handbook on how local officials could work together to protect groundwater quality, a computer program that facilitates collection of water test results, and techniques to encourage or fund the testing of well water. In Wisconsin, ES-USDA has funded the development of educational materials that would help individual counties to identify areas at risk for groundwater contamination, and the targeting of educational programs to audiences in those areas. In New York, Cornell University was contracted to develop a teaching program on groundwater protection. ES-USDA attempts to help local governments deal more effectively with groundwater protection by developing educational programs for use at the local level. (See also W91-10423) (MacKeen-PTT) W91-10442

## INTEGRATED PEST MANAGEMENT: A TOOL TO MANAGE THE RISK OF GROUND WATER CONTAMINATION.

CONTAMINATION.
Minnesota Univ., St. Paul. Dept. of Entomology, Fisheries, and Wildlife.

K. Ostlie.
IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 319-326. 1 fig, 2 tab.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Agriculture, \*Groundwater pollution, \*Pesticides, \*Water pollution control, Agricultural community, Economic aspects, Groundwater quality, Integrated pest management, Water pollution prevention, Water quality

Integrated pest management (IPM) provides a tool for effectively managing pest populations, while minimizing groundwater contamination by agricultural pesticides. Use of pesticides under IPM is based upon field observations of pests present, and upon sound economic bases. In some cases, such as Minnesota's European corn borer and potato leafnopper, IPM programs are likely to increase pesticide use, at least temporarily. An example of an IPM program used in Minnesota which resulted in decreased pesticide use is that for control of the sunflower beetle. By educating farmers on how much defoliation sunflower plants can tolerate and through research on optimizing pesticide applica-

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### **Group 5G—Water Quality Control**

tion rates, Minnesota has achieved a 90% reduction in the chemical used against the sunflower beetle. Principles followed by IPM programs to reduce the risk of groundwater contamination include: use of alternatives to pesticides; economic thresholds for determining when use of pesticides is economically justified; and selection of pesticides based on activity, persistence, solubility, and soil adsorption. Herbicide use in Minnesota corn production could be reduced by banding instead of broadcasting, and by testing the soil for organic matter, pH, and soil texture to determine proper application rates. In soybean production, postemergence compounds and economic thresholds may reduce the potential for groundwater consumer testing the solution of the production of the solution of the sol reduce the risk of groundwater contamination inmay reduce the potential for groundwater con-tamination. In the past 10 years there has been a large shift towards crop rotation to control insects in Minnesota corn production, and a 45% reduction in insecticide use. It is concluded that IPM, by uon m insecticide use. It is concluded that IPM, by promoting the judicious use of pesticides, provides a valuable tool for reducing groundwater contami-nation by agricultural pesticides. See also W91-10423) (MacKeen-PTT) W91-10443

PESTICIDES AND PUBLIC HEALTH: INDUSTRY'S ROLE IN RISK MANAGEMENT.
National Agricultural Chemicals Association, Washington, DC.

J. F. McCarthy. J. F. McCarthy.
IN: Pesticides and Groundwater: A Health Concern for the Midwest. Proceedings of a conference sponsored by the Freshwater Foundation and the U. S. Environmental Protection Agency, St. Paul, MN, October 16-17, 1986. Freshwater Foundation, Navarre, Minnesota. 1987. p 327-333.

Descriptors: \*Chemical industry, \*Pesticides, \*Public health, \*Risk management, \*Water pollution control, \*Water quality standards, Agricultural chemicals, Education, Groundwater pollution, Legislation, Risk assessment, Water pollution pre-

Results of a public attitude survey conducted by the National Agricultural Chemicals Association (NACA) indicated an increase in public concern with pesticide use and little acceptance of any amount of chemicals in drinking water. Industry generates the data on which EPA bases its determination of the risk of adverse effects of a pesticide. Industry also plays a role in both legislative/ regulatory initiatives at federal and state levels and voluntary industry initiatives. NACA and the Campaign for Pesticide Reform reached an accord on far-reaching changes in existing federal legisla-tion. The proposed legislation requires action before a health-based standard concentration of pesticide is reached, and cessation of pesticide use if the standard is exceeded. Amendments to the registration of a pesticide will be required if Groundwater Residue Guidance Levels would be Groundwater Residue Guidance Levels would be exceeded by continuing use of the pesticide. Industry initiatives include publications on health guidance levels of pesticides, and 'Protecting Our Groundwater: A Grower's Guide', which describes some common sense practices to minimize contamination. It is concluded that NACA is compitted to each identification and eight memorane. mitted to risk identification and risk management of pesticides. (See also W91-10423) (MacKeen-PTT) W91-10444

WATER QUALITY AND IRRIGATION. Texas A and M Univ., College Station. Dept. of Agricultural Engineering. M. J. McFarland.

M. J. McPariand.
IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 33-35.

Descriptors: \*Agricultural chemicals, \*Agricultural runoff, "Irrigation practices, "Water pollution prevention, "Water quality control, Application rates, Farm management, Irrigation effects, Sur-face runoff, Texas, Water quality management.

Irrigation and water quality have two different aspects. One is irrigation management with water of impaired quality as a result of total salinity or an

excess of certain ions such as sodium. The other is the influence of irrigation on impaired water quality caused by herbicides, pesticides and fertilizers. Contaminated surface and ground water as a result of agricultural chemicals should not be a problem in South Texas because proper use of chemicals will result in negligible movement of chemicals to a water source. Best management practices (BMPs) that address environmental quality focus on either the reduction of the potential pollutant applied to the land or on the amount of pollutant entering the ponds, streams, and groundwater. Good water management will decrease the potential for movement of chemicals from a field. A water management program should minimize the surface runoff and the drainage below the root zone. Techniques that reduce the concentration of chemicals at or on the soil surface will reduce the potential for off-field movement of these chemicals. When runoff will occur from irrigation or rains, the chemical management program ideally should produce a situation where there is no chemical available to move with the water and sediment. This involves scheduling of chemical applications after an irriga-tion and during dry weather periods, when possible. Best management practices, common sense, and knowledge of the specific chemicals can be effectively utilized to decrease the potential for pollution of water supplies and the environment. In general practices that reduce the volume of chemicals applied, reduce the concentration of chemicals applied, reduce the concentration of chemicals. at the soil surface, and reduce the volume of water and sediment runoff will be effective. (See also W91-10445) (VerNooy-PTT)

CHEMIGATION WITH LEPA CENTER

Texas Agricultural Extension Service, Texas A&M University, Amarillo, TX.
For primary bibliographic entry see Field 3F. W91-10454

SAMPLING PROBLEMS FOR THE CHEMI-CAL ANALYSIS OF SLUDGE, SOILS AND PLANTS.

For primary bibliographic entry see Field 5A. W91-10461

#### 6. WATER RESOURCES PLANNING

#### 6A. Techniques Of Planning

WATER-QUALITY IMPACT ASSESSMENT FOR HYDROPOWER. HYDROEXYGIANTIKI, Evias 3, 15125 Mar-For primary bibliographic entry see Field 5G. W91-09385

SENSITIVITY OF FURROW IRRIGATION SYSTEM COST AND DESIGN VARIABLES. Wyoming Univ., Laramie. Dept. of Agricultural

Engineering.
For primary bibliographic entry see Field 3F.
W91-09394

TRANSFERRING MODELS TO USERS. For primary bibliographic entry see Field 7C. W91-09570

TRANSFERRING A GIS WATER PLANNING MODEL TO USERS: THE WASATCH FRONT STUDY. Utah State Univ., Logan. Dept. of Civil and Envi-

ronmental Engineering.
For primary bibliographic entry see Field 7C.
W91-09571

FOREST MANAGEMENT NONPOINT SOURCE RISK ASSESSMENT GEOGRAPHIC INFORMATION SYSTEMS APPLICATION, National Weather Service R. 1 National Weather Service, Tulsa, OK, River Fore-

cast Center. For primary bibliographic entry see Field 4D. W91-09573

DEVELOPMENT OF A WATER SUPPLY OP-ERATION MODEL FOR THE CITY OF NORTHGLENN, COLORADO. For primary bibliographic entry see Field 7C.

VISUALIZATION OF WATER RESOURCE SYSTEM SIMULATION MODEL OUTPUT. Colorado Univ. at Boulder. Dept. of Civil, Environmental, and Architectural Engineering. For primary bibliographic entry see Field 7C. W91-09577

FROM USEFUL TO REALLY USABLE: SOFT-WARE FOR WATER RESOURCES PLANNING AND MANAGEMENT.

International Inst. for Applied Systems Analysis, Laxenburg (Austria). For primary bibliographic entry see Field 7C. W91-09578

'EXPERT CONSULTANT': AN FOR ENGINEERING ANALYSIS. AN APPROACH

Colorado State Univ., Fort Collins. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C.

NUMERICAL MODEL USES AND LIMITATIONS FOR GROUND WATER MANAGE-MENT.

Butler Univ., Indianapolis, IN. Holcomb Research

G. H. Grondin, and K. E. Lite.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 121-129. 25 ref. U. S. Environmental Protection Agency Agreement No. CR-0715363.

Descriptors: \*Data interpretation, \*Groundwater management, \*Hydrologic models, \*Mathematical models, \*Model studies, \*Planning, \*Water re-sources management, Computer models, Geohy-drology, Groundwater level, Groundwater move-ment, Groundwater use, Technology transfer.

Oregon groundwater law charges the state to determine and maintain reasonable groundwater levels in aquifers while assuring a perpetually adequate and safe supply for beneficial uses. This groundwater management charge has a regional, local and site areal component, as well as a temporal component. The areal extent of aquifers in Oregon ranges from several square miles to hundreds of square miles. Many of the local geologic features control groundwater flow and affect local groundwater use. A numerical groundwater model of an Oregon aquifer larger than ten square miles could help the state manage the resource regionally, but it could also cause the state to mismanage the resource locally by dampening or missing the effect of local geologic features on local ground-Oregon groundwater law charges the state to dethe resource locally by dampening or missing the effect of local geologic features on local ground-water flow and use. The choice of scale could also cause the state to miss existing or pending well interference or other problems. Conversely, a numerical groundwater model of the local hydrogeologic system could overlook important regional influences. Therefore, Oregon and similar states need groundwater models that efficiently couple site models to local models and local models to a regional model. Such models will allow the state to analyze and manage groundwater both regionally and locally. (See also W91-09570) (Author's abstract) W91-09582

DEVELOPMENT OF A WATERSHED MAN-AGEMENT MODEL.

CH2M Hill, Inc., Atlanta, GA.
For primary bibliographic entry see Field 4D.
W91-09599

### **Evaluation Process—Group 6B**

SIMULATION COMPUTER MODEL AS A BASIS FOR REVISING A PROJECT OPERAT-

Public Utility District No. 1 of Snohomish County,

For primary bibliographic entry see Field 7C. W91-09608

MODEL FOR SAVING RESOURCES, WRC Inc., Huntington, PA. For primary bibliographic entry see Field 5F. W91-09772

PRESCRIPTION PLANNING: AN APPROACH TO NONPOINT POLLUTION PROBLEMS.
South Dakota State Univ., Brookings. Dept. of

For primary bibliographic entry see Field 5G. W91-09881

INTEGRATED APPROACH TO WATER RE-SOURCES MANAGEMENT: THE CARROLL COUNTY, MARYLAND STORY. Bureau of Water Resource Management, Carroll County, Maryland, 225 N. Center Street, Westmin-ster, Maryland 21157.

P. S. Thomas.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 259-261, 1990.

Descriptors: \*Groundwater resources, \*Interagency cooperation, \*Land development, \*Land use, \*Local governments, \*Water pollution management, \*Water resources management, Databases, Education, Funding, Maryland, Water permits.

The Carroll County Water Resource Management Program is designed as a comprehensive, county-wide approach to resource management. It is im-plemented on the basis of site-specific criteria. The main components include the following: mainte-nance and improvement of existing supplies and sources; development of new sources; protection of water quality; delineation of water resource or water quantity definition of water resource protection/management areas; development and maintenance of a data base; aggressive promotion of public education; evaluation of potential funding mechanisms, promotion of a countywide water conservation program; maintenance and/or strengthening by town, county, state and federal cooperation; and establishment of a county permit and inspection process for water resource management. Progressive land use regulations have been drafted based on concept-of-performance standards and designed to accomplish the goals set forth for water resource protection, while at the same time allowing for the prudent, managed growth and development of towns and the county. (Feder-PTT) W91-09888

RIVER BASIN MODELING VIA SYSTEMS ANALYSIS AND ARTIFICIAL INTELLI-GENCE.

Montana State Univ., Bozeman. Dept. of Industrial and Management Engineering. For primary bibliographic entry see Field 7C. W91-10037

WE NEED A HYDROLOGY MANUAL. Floodplain Management Division, Kern County Department of Planning and Development Serv-For primary bibliographic entry see Field 7C. W91-10041

MANAGING TROUBLED WATERS: THE ROLE OF MARINE ENVIRONMENTAL MON-

ITORING.
National Research Council, Washington, Committee on a Systems Assessment of Marine Environmental Monitoring. For primary bibliographic entry see Field 5G. W91-10061

COMPUTERIZATION OF THE DECISION-MAKING FRAMEWORK.

AScI Corp., Duluth, MN. C. H. Lutz, V. A. McFarland, and B. L. Folsom. Army Corps of Engineers Information Exchange Bulletin, Vol. D-90-2, August 1990. p 6-8, 1 fig. 3

Descriptors: \*Automation, \*Computer programs, \*Decision making, \*Dredging wastes, \*Waste disposal, Computers, Management planning, Sediment contamination, Sedimentation.

The general Decisionmaking Framework (DMF) for management of dredged material was developed to provide a systematic approach for selecting the best option for placement of dredged sediing the best option for placement of dredged sedi-ments based on environmental concerns, cost, and site availability. Using a tiered testing approach, the DMF first guides the user to a decision as to whether there is a 'reason to believe' sediment whether there is a 'reason to believe' sediment contamination may require disposal restrictions. The tiered approach allows the necessary and sufficient level of testing to be used for each specific project. The DMF computer software allows the user to easily navigate through the flow charts and will display prompts identifying required data inputs before proceeding to the next step. The first time this software is used on a test sediment, the service to required to provide bulk chemical analysis. user is required to provide bulk chemical analysis of the test sediments and of a reference sediment. Once these data are entered into the program, they are automatically saved on disk as discrete databases and may be recalled for future use. Depending upon which module is chosen, other specific data, such as bioassay or bioaccumulation test re-sults, may be required. Once they have been entered, data may be shared among all modules with-out the need for reentering. This feature will also allow the user to investigate multiple disposal al-ternatives with minimal effort. (Lantz-PTT) W91-10066

NEW STAGE OF DEVELOPMENT OF HY-DROLOGY--WATER RESOURCES HYDROLO-

Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).

For primary bibliographic entry see Field 2A. W91-10106

EXPERT SYSTEMS IN WATER RESOURCES. Georgia Inst. of Tech., Atlanta. School of Civil

Georgia Ins.
Engineering.
S. Rouhani, and R. Kangari.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 457-462, 1 fig, 9 ref.

Descriptors: \*Computer programs, \*Expert systems, \*Model studies, \*Site selection, \*Underground waste disposal, \*Water resources management, Artificial intelligence, Case studies, Economic aspects, Hydrologic aspects, Model testing, Social aspects

Development and management of water resources systems involve many complicated problems rang-ing from the hydrological to the socio-economic aspects. A typical hydroplanning procedure requires a significant amount of empirical inputs from experts and specialists. Information of this pe can be denoted as empirical knowledge, hich includes heuristic rules, expert opinions and which includes and rules of thumb. Utilizing recent advances in artificial intelligence techniques, expert systems may be devised to bridge the gap between novice hydrologists and experts; to create a mechanism for conceptualization, formulation, and validation of the existing expert rules; and finally, to establish a store of empirical knowledge of past and present practitioners for the benefit of future students. A prototype model for waste dis-posal site selection has been developed. This system is a self-explanatory model based on rules suggested by the U.S. Environmental Protection Agency. As a case study, a waste disposal site selection program was examined, considering groundwater route characteristics, waste characteristics. teristics, facility characteristics, and targets. A score was assigned to each of these factors and used to derive an overall site score (the higher the

score, the more preferred the site). This model can be utilized by hydrogeologists for preliminary site selection processes. It can also be used by students to gain synthetic experience to organize their thought processes. (See also W91-10103) (Author's abstract) W91-10144

PLANNING AND LEGAL RESPONSES TO SEA-LEVEL RISE IN SOUTH AFRICA. Cape Town Univ. (South Africa). Dept. of Environmental and Geographical Science.
For primary bibliographic entry see Field 2L.
W91-10180

COASTAL DUNES AS INDICATORS OF ENVI-RONMENTAL CHANGE. Port Elizabeth Univ. (South Africa). Dept. of Ge-

ology. For primary bibliographic entry see Field 2L. W91-10181

ROLE OF MODELING IN DEVELOPING COST-EFFECTIVE AND ENVIRONMENTAL-LY SAFE PEST MANAGEMENT PROGRAMS, Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5G.
W91-10393

#### 6B. Evaluation Process

PROBLEMS AND POTENTIAL OF IRRIGAT-ED AGRICULTURE IN SUB-SAHARAN AFRICA. For primary bibliographic entry see Field 3F. W91-09391

IMPROVING MANAGEMENT OF INTRA-STATE AND INTERSTATE WATER TRANS-FER IN THE EASTERN UNITED STATES. Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6E.
W91-09567

UTILIZATION AND MANAGEMENT OF COASTAL AREAS IN KUWAIT. COASIAL AREAS IN RUWAII. Kuwait Inst. for Scientific Research, Safat. Environmental and Earth Sciences Div. M. M. Abous-Seida, and M. A. Al-Sarawi. Coastal Management CZMJBF, Vol. 18, No. 4, p 385-401, 1991. 9 fig, 18 ref.

Descriptors: \*Coastal waters, \*Coastal zone management, \*Coasta, \*Kuwait, \*Water resources management, Administration, Administrative regulations, Interagency cooperation, Management planning, Operating policies.

Kuwait's coastal area is considered to have special importance because most urban, industrial, com-mercial and recreational activities are concentrated in this zone. It also represents the main source of freshwater and electricity in the country. Besides, the coastal zone has a unique ecosystem and is a significant nursing ground for fish and shrimp. Coastal characteristics include variations of tides, Coustal characteristics include variations of titles, currents, and waves acting on: a soft, muddy, intertidal flat; a sandy-rocky tidal flat; artificial, man-made sandy beaches, sandy beaches found in the open coastline; oolitic limestone beaches; and coral reefs. Utilization of the Kuwait coastal zone includes: power desalination plants and industrial discharges; harbors and marinas; and recreational discharges; harbors and marinas; and retreational and other coastal activities. Plans to use the coastal area initially included proposals for the recreational development of the coastline, a major onshore coastal motorway, recommended growth of urban areas and establishment of several marine park areas. Government authority in Kuwait is structured to the control of the coastline of the coastli areas. Government authority in Kuwait is struc-tured on national and local authorities. The agen-cies that have a particular impact on the coast are in the areas of planning, water and power, city physical planning, human health, and transport and trade. Management problems associated with plan-

#### Field 6-WATER RESOURCES PLANNING

#### **Group 6B—Evaluation Process**

ning may be divided into two distinct categories: ining have divided into we distinct chargonies, technical (conflict between coastal zone users; environmental pollution; destruction of coastal habitats by dredging and filling; and residential admindustrial demands) and organizational (poor coordination among coastal users and management agencies; lack of information; absence of a planning, coordinating, and regulatory body; and lack of public awareness). The essential elements for managing the Kuwaiti coast are: clearly articulated policies; designation of a leading agency; ensuring the availability of baseline data, analysis, and trained manpower; and power to achieve coordina-tion and follow-up. (Fish-PTT)

ESTIMATION OF GROUNDWATER PROTECTION BENEFITS AND THEIR UTILIZATION BY LOCAL GOVERNMENT DECISION-MAKERS.

MAKERS, New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. J. R. Powell, and D. J. Allee. Available from National Technical Information Service, Springfield, VA 22161 as PB91-141929/ AS. Price codes: Al 0 in paper copy, A02 in micro-fiche. Final Report, 1990. 192p, 14 fig. 19 tab, 7 ref, 4 append. USGS Contract No. 14-08-0001-G1649.

Descriptors: \*Benefits, \*Decision making, \*Economic aspects, \*Groundwater protection, \*Local governments, \*Water supply, Attitudes, Economic evaluation, Massachusetts, New York, Pennsylvaia, Public opinion, Regression analysis, Surveys, Willingness-to-pay.

A contingent valuation survey was conducted on households in 12 communities. Each relies on groundwater for public water supply and seven have experienced contamination in the past ten years. Large differences in willingness-to-pay for increased water supply protection were found. years. Large differences in willingness-to-pay for increased water supply protection were found, both within and across communities. Differences in household willingness-to-pay were found between groups that have, and groups that have not, experienced contamination. Regression analysis revealed income, experience of a contamination incident, perception of water supply safety, and perception of potential sources of contamination, significantly affect household willingness-to-pay for increased protection. Personal interviews with key informants ascertain perceptions of the resource, and protection. Personal interviews with key informants ascertain perceptions of the resource, and attitudes to contamination and protection. Content analysis provided evidence that contamination has little impact on adoption of local ordinances to protect sources. Source protection was the result of interaction between hydrogeologic characteristics, local perception of those characteristics, state and local institutional organization, and perceived level of community growth. Content analysis also supplied five water supply protection concepts which were used, along with willingness-to-pay in a cognitive mapping technique. Results suggest contingent value information has an impact on key informant's understanding of the causal relationships between the six concepts. (USGS) W91-09825

BIOECONOMIC ANALYSIS OF WATER AL-LOCATIONS AND FISH HABITAT ENHANCE-MENTS, JOHN DAY BASIN, OREGON. Oregon State Univ., Corvallis. Dept. of Agricul-tural and Resource Economics. R. M. Adams, P. C. Klingeman, and H. W. Li. Available from National Technical Information Service, Springfield, VA 22161 as PB91-143123/ AS. Price codes: A09 in paper copy, A01 in micro-fiche. Final Report, August 1990. 168p, 47 fig, 28 tab, 164 ref, 2 append. USGS Contract No. 14-68-0001-G1479. 0001-G1479

Descriptors: \*Anadromous fish, \*Aquatic habitats, \*Bioeconomic analysis, \*Economic aspects, \*Water allocation, Columbia River Basin, Instream flow, John Day River, Oregon, Recreation, Salmon, Streamflow augmentation, Trout, Water resources development, Water temperature, Water

The study uses an interdisciplinary approach to assess the economic efficiency of water allocations

and fish habitat enhancements for chinook salmon and steelhead trout in the John Day River Basin,
Oregon. Specific enhancements included water
transfers to instream flow, habitat vegetation improvements, and habitat structural measures. The benefits of improved fish productivity included recreation and commercial uses. Streamflow and water temperature were found to be critical limiting factors in a majority of habitats. Low dis-charges posed limitations at sites where temperatures were elevated and at habitats where channel structure was simple. Attempts to improve habitat structure was simple. Attempts to improve habitat solely by increasing structural complexity were seldom successful. The economic efficiency of streamflow augmentation and habitat investments varied across sites, suggesting that policies to enhance fish production need to be tailored to local conditions. (USGS)
W91-09826

PUBLIC POLICY PERS GROUNDWATER QUALITY. PUBLIC PERSPECTIVE

Florida Univ., Gainesville. Dept. of Food and Resource Economics.

L. W. Libby. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 190-193, 1990. 14 ref.

Descriptors: \*Groundwater quality, \*Institutions, Policy making, "Public participation, "Public policy, "Social aspects, "Water policy, "Water pollution control, Behavior, Economic aspects, Groundwater management, Groundwater pollution tion. Water use.

Groundwater pollution problems are fundamentally institutional problems. The means for reducing contamination are institutional: the mix of incencontamination are institutional: the mix of incentives, rights and obligations confronting resource users. Only changes in the rights and obligations of users or the economic and social cost of water use users or the economic and social cost of water use options will reduce groundwater pollution. Policy is the process by which those changes are made. The essential purpose of groundwater quality policy is to change water use behavior. For the most part, people do respond to evidence that a failure to change could be painful. New information can produce the support necessary for regulation or other policy change. It is essential to maintain healthy respect for the rights and intentions of individuals. Improved understanding of human beindividuals. Improved understanding of human behavior is essential to success in groundwater policy. (Feder-PTT) W91-09869

COMMUNICATING WATER QUALITY RISK, Cornell Univ., Ithaca, NY. Dept. of Communica-

For primary bibliographic entry see Field 5G. W91-09871

INFORMATIONAL NEEDS FOR LOCAL GROUNDWATER MANAGEMENT DECI-

Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection. For primary bibliographic entry see Field 4B. W91-09877

COMPREHENSIVE APPROACH GROUNDWATER MANAGEMENT RURAL LOCAL GOVERNMENTS. FOR

Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology. For primary bibliographic entry see Field 4B. W91-09878

TEN YEARS OF COMPUTERIZATION-A CASE STUDY.

ASL Engineering, Inc., Santa Barbara, CA For primary bibliographic entry see Field 7C. W91-10024

FAMINE IN AFRICA.
Foreign Agricultural Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W91-10094

REMOTE SENSING AND AGRICULTURAL IN-FORMATION FOR CROP FORECASTING: SUDAN EXPERIENCE,

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div. For primary bibliographic entry see Field 7B.

W91-10095

W91-10097

US AID: REMOTE SENSING AND FORESTRY. Agency for International Development, Washington, DC. Office of Science and Technology. For primary bibliographic entry see Field 7B.

SOCIO-ECONOMIC IMPACT OF DEVELOP-MENT SCHEMES IN THE 'HOMELANDS' OF SOUTH AFRICA.

Rhodes Univ., Grahamstown (South Africa). Dept. of Anthropology. C. de Wet.

South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 440-447, July/October 1990. 61 ref.

Descriptors: \*Ecological effects, \*Economic aspects, \*Land use, \*Resources development, \*Social aspects, \*South Africa, Agriculture, Erosion, Irrigation effects, Leaching, Path of pollutants, Plant growth, Saline soils.

Development schemes in rural areas have a significant ecological impact as they often involve a reorganization of land-use and resource utilization reorganization of land-use and resource utilization patterns. This reorganization is usually intended to have a positive ecological effect by combating erosion, promoting rational land-use patterns and using the potential of the area to best effect, thereby providing economic benefits to the people living in the area. Often development schemes have the opposite effect, and cause negative ecological and economic impact as well as causing considerable social disruption, which in turn has further negative ecological consequences. Four kinds of agricultural development projects (maize production scheme, betterment schemes, cattle schemes, irrigation schemes) have been implemented in South Africa. Depending on the salinity of schemes, irrigation schemes) have been implemented in South Africa. Depending on the salinity of
the water used, irrigation may have negative effects upon the growth of certain crops, as well as
upon soil structure. The leaching of soils which
have a high salinity may affect the salinity level of
the water in the area around agricultural development, with potentially negative effects for the local
vegetation. (Brunone-PTT) W91-10190

ASSESSMENT OF IMPACTS ASSOCIATED WITH DRIER OR WARMER SCENARIOS.

University of the Witwatersrand, Johannesburg (South Africa). Dept. of Geography and Environmental Studies

For primary bibliographic entry see Field 2B.

ROLE OF EDUCATION AND INCENTIVES.

Clemson Univ., SC. For primary bibliographic entry see Field 5G. W91-10395

AGRICULTURAL MANAGEMENT PRACTICES TO MINIMIZE GROUNDWATER CONTAMINATION AND A SITE-SPECIFIC FARM ASSESSMENT PROCESS.

For primary bibliographic entry see Field 5G. W91-10398

NEW TEXAS WATER PLAN: IMPLICATIONS FOR IRRIGATED AGRICULTURE.

Texas Water Development Board, Austin.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991.

#### Water Demand—Group 6D

Descriptors: \*Comprehensive planning, \*Irrigation efficiency, \*Planning, \*Regional planning, \*Texas, \*Water conservation, \*Water policy, \*Water resources management, \*Water use, Drip irrigation, Future planning, Irrigation requirements, Long-term planning, Water demand, Water use efficien-

The primary objective of the Texas Water Plan is to provide a continuing comprehensive assessment of the current and future status of water-related or the current and future status of water-related resources within the State and to provide workable strategies that will serve as a guide to State policy for the development, management, conservation and protection of the State's water resources. The 1990 Water Plan identifies alternative approaches age water resources, makes recommen to manage water resources, makes recommenda-tions for policy and program formulation and im-plementation, and gives public and private institu-tions direction to: (1) provide for sufficient quanti-ties of water; (2) protect the quality of both surface ties of water; (2) protect the quality of both surface and groundwater, and (3) safeguard human life and property from flooding and flood damage. In a number of areas of Texas today, available yield of existing surface water supplies will barely be sufficient to meet water demands during a critical drought period. Total water use requirements in Texas are projected to increase over the 50 year alonairs. Authorized water were requirements. planning horizon. Municipal water requirements are projected to become the major water demand category in several regions as the population in-creases. For irrigation water, a projection of 20% increased water use efficiency per acre, resulting from adoption of improved management and water conservation procedures was made for water use scenarios studied. Five major on-farm irrigation water conservation practices which should be implemented include: (1) low energy precision application (LEPA) sprinklers (2) surge flow furrow irrigation valves, (3) drip irrigation, (4) soil moisture measurement, and (5) use of on-farm understanding the content of the conten ground water distribution pipelines. (See also W91-10445) (VerNooy-PTT) W91-10447

SUCCESSES AND FAILURES OF LOAD MAN-

AGEMENT PROGRAMS FOR IRRIGATION.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.

Agricultural Engineering. G. L. Stark. IN: Proceedings of: South Texas Irrigation Confer-ence, January 15, 1991, Hondo, Texas. Texas Agri-cultural Extension Service, College Station. 1991. p 61-70. 1 tab, 2 ref.

Descriptors: \*Agricultural water, \*Discount rates, \*Electric power demand, \*Irrigation efficiency, \*Irrigation practices, \*Management planning, \*Peak loads, \*Pumping, Economic aspects, Electric power costs, Electric power rates, Electricity, Farm management, Resources management, Texas, Water conservation

With properly designed and implemented load management strategies, utilities can reduce demand costs, prevent overloading on their distribution systems, and often delay the need for power plants. Irrigation load management can also enhance electricity marketing by providing electric power for irrigation at extremely competitive rates well below the costs of other fuel sources. The power supplier must carefully assess its electrical demand suppiler must carefully assess its electrical demand costs, as related to serving crop irrigation systems, and be prepared to share projected savings with the irrigators through appropriate rates and incentives. A variety of control options, with selected hours per day or days per week, must be offered to allow for differences in irrigation methods, crops allow for differences in irrigation methods, crops and management systems. Load management options provide irrigators with the opportunity to reduce overall operating costs; however, irrigators must be able to choose options that will fit crop and system requirements. Any program will have a much greater chance of success if it is developed from the wants and needs of the consumer, rather than from specific interests of the power supplier. Utilities have found that part of any load manage. Utilities have found that part of any load management or marketing program should include recomendations to assist consumers in reducing energy waste. Irrigation pumps and related equipment are significant energy users and many different procedural or equipment changes can be used to im-

prove the efficiency of both energy and water use. (See also W91-10445) (VerNooy-PTT) W91-10451

#### 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

FUNDAMENTALS AND TRENDS OF WATER SERVICES IN A NIGERIAN URBAN SETTLE-

Ibadan Univ. (Nigeria). Dept. of Agricultural En-

gineering.
A. Y. Sangodoyin.
Environmental Education & Information
EEDIEF, Vol. 9, No. 4, p 181-198, 1990. 3 fig, 2

Descriptors: \*Drinking water, \*Human population, \*Mathematical models, \*Municipal water, \*Nigeria, \*Water distribution. \*Water resources management, Domestic water, Economic aspects, Questionnaires, Reservoirs, Statistical analysis, Urban watersheds, Water requirements.

Life is at risk when adequate quantities of water are not readily available. The importance of pota-ble water cannot be overemphasized, and its provible water cannot be overempnasized, and its provi-sion in most urban settlements is hindered by lack of finances and/or faulty management. An exten-sive survey and data analysis quantified the influ-ence of location of residence, source of water supply, size of family and storage strategies on water distribution, consumption, and pricing in Ibadan Municipality, Nigeria. To further under-stand the complex relationships between water dis-tribution, storage and consumption, a statistical tribution, storage and consumption, a statistical model using correlation coefficients was construct-ed. The water obtained from two large reservoirs supplying the city was compared with established standards. An increased desire for better service (quality and quantity) seems to be responsible for the willingness of respondents to pay for anticipat-ed improvement. The uncertain quality of alterna-tive water sources, as well as the time and cost associated with water purification, are factors in-fluencing respondents' preferences for a municipal piped source of water. Patterns of domestic use varied with family size, lifestyle, education, and location. Provision of facilities to accommodate these differences is required so that water policies can succeed. Collection and analysis of water re-quirements and consumption data, rather than estimated figures, is important in achieving goals like these. (Brunone-PTT)
W91-09365

## EFFICIENT SPATIAL ALLOCATION OF IRRIGATION WATER.

Hawaii Agricultural Experiment Station, Honolu-

For primary bibliographic entry see Field 3F. W91-09441

COST OF NOT HOLDING BACK THE SEA: TOWARD A NATIONAL SAMPLE OF ECONOMIC VULNERABILITY.

Wesleyan Univ., Middletown, CT. For primary bibliographic entry see Field 5C. W91-09696

### COSTS OF GROUNDWATER CONTAMINA-

Environmental Protection Agency, Washington, DC. For primary bibliographic entry see Field 5C. W91-09867

GROUNDWATER POLLUTION'S ON RESIDENTIAL PROPERTY PORTAGE COUNTY, WISCONSIN. EFFECTS VALUES, For primary bibliographic entry see Field 5C. W91-09909

FINANCIAL COMPUTER MODEL FO STORMWATER MANAGEMENT ANALYSIS. Georgia Inst. of Tech., Atlanta

T. N. Debo, and R. Phillips IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p 11-14. 3 fig.

Descriptors: \*Computer models, \*Cost analysis, \*Economic aspects, \*Evaluation, \*Financial feasibility, \*Model studies, \*Storm runoff, \*Storm water management, \*Urban hydrology, Budgeting, Computer programs, Costs, Urban planning, Urban runoff, Urban watersheds, User

Finding the resources to implement urban stormriming the resolutes to implement urona storm-water management programs is an ever increasing problem for many municipalities. In recent years, impact fees and user fees have been used to aug-ment traditional funding sources from governmen-tal budgets and bond issues. Recently two stormtai ouigets and ond issues. Recently two storm-water management programs were developed in the southeast, and which included the development of a financial computer model for use in evaluating the costs and funding necessary to implement these programs. One model the CAPFIN model develprograms. One model the CAPFIN model developed to assist municipalities in the development and implementation of capital improvement programs related to the future development of their infrastructure system. The model uses the LOTUS 1-2-3 program with a series of menus to assist the user through data input and output. Subroutines have been included in the model which makes it wery easy for users to apply the model to local very easy for users to apply the model to local conditions and obtain results in tabular or graphical form. The CAPFIN model is presently being used to assist in the development and analysis of user fees to help pay for future developments in the infrastructure needed to accommodate future urban development. (See also W91-10018) (Korn-TTT) PTT W91-10052

#### 6D. Water Demand

ASSESSING THE RELIABILITY OF URBAN RESERVOIR SUPPLIES.

Indianapolis Water Co., IN. J. D. Bakken, and T. M. Bruns. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 3, p 46-51, March 1991. 1 fig, 1 tab, 7 ref.

Descriptors: \*Dam safety, \*Reservoir operation, \*Indiana, \*Reservoir silting, \*Reservoir storage, \*Water resources management, \*Water supply, Capital costs, Dams, Economic aspects, Indianapo-Reservoir yield, Storage, Storage capacity, Storage reservoirs.

A comprehensive study of multiple-reservoir water supply sources involves several elements. The Indianapolis Water Company (IWC) conducted a thorough study of reservoir supplies to assess the reliability of its water supply system. The reservoir volume surveys found that about 11.6% percent of the storage capacity of Geist Reservoir was lost through sedimentation from 1943 to 1980 and about 12.9% of the Morse Reservoir volume was lost between 1957 and 1978. A detailed dependable lost between 1957 and 1978. A detailed dependable yield analysis indicated that as much as 139.4 mgd could be obtained on a reliable basis if available storage is fully utilized and the operation of the three reservoirs is coordinated. Based on the recent studies, the amount of raw water supply available to the IWC distribution system was increased by almost one-fourth, with no attendant capital costs almost one-fourth, with no attendant capital costs to construct new reservoirs or develop other sources of water supply. The safety of Morse and Geist dams was evaluated, and both were found to be structurally and hydraulically sound. An ongoing IWC monitoring and inspection program will ensure that they remain structurally sound and continue to provide water for Indianapolis in the future. The total cost of the engineering studies by outside consultants to review storage volumes, deputside consultants to review storage volumes, deoutside consultants to review storage volumes, de-pendable yield of existing sources, and dam safety as part of IWC's effort to evaluate reservoir system reliability was \$233,000. This amount was only 1% of the estimated cost of constructing new sources of supply to yield a similar increase in system dependable yield. (Brunone-PTT) W91-09402

#### Field 6-WATER RESOURCES PLANNING

#### Group 6D-Water Demand

WATER USE IN SOUTH CAROLINA, 1985. Geological Survey, Columbus, OH. Water Resources Div.

W. J. Stringfield, and S. C. Lambert. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4098, 1990. 27p, 17 fig, 1 tab, 19 ref.

Descriptors: \*Cooling water, \*Industrial water, \*Irrigation water, \*Municipal water, \*South Carolina, \*Water use, Coastal plains, Groundwater, Hydroelectric power, Selective withdrawal, Surface

Approximately 6,720 million gal/day of freshwater Approximately 6,720 million gal/day of Ireshwater were withdrawn in 1985 from South Carolina's streams, rivers, lakes, and aquifers for public supply, irrigation, industry, and thermoelectric power generation. This compares to 5,790 million gal/day withdrawn during 1980, or an increase of 16%. Surface water was the source for 98% of all freshwater withdrawals and ground water was the source for the remaining 2%. Thermoelectric source for the remaining 2%. Inermoelectric power generation accounted for 77% of the total withdrawal, industry, 17%; public supply, 5%; and agricultural use, 1%. An additional withdrawal of 118 million gal/day was estimated for miscellaneous uses such as domestic, commercial, livestock, and mining. Instream or non-withdrawal use of water for hydroelectric power generation account-ed for 42,100 million gal/day, which is six times greater than the total of all withdrawal uses. (USGS) W91-09494

#### NATIONAL WATER SUMMARY 1987--HY-DROLOGIC EVENTS AND WATER SUPPLY AND USE

Geological Survey, Reston, VA. Water Resources

Div. Available from National Technical Information Service, Springfield, VA 22161 as PB91-107334/AS. Also from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. Price codes: PC A24 in paper copy. USGS Water-Supply Paper 2350, 1990. 568 p, 411 fig, 19 tab. Compilers: J. E. Carr, E. B. Chase, R. W. Paulson, and D. W. Moody.

Descriptors: \*Agricultural water, \*Consumptive Descriptors: "Agricultural water, "Consumptive use, "Domestic water, "Hydrologic aspects, "Industrial water, "National Water Summary, "Return flow, "United States, "Water sources, "Water supply, "Water use, Chemical industry, Commercial use, Food processing industry, Irrigation, Livestock, Mineral industry, Oil industry, Puerto Rico, Pulp and paper industry, Steel industry, Virgin Islands(US).

This report, which is the fifth of an annual series describing the Nation's water resources, focuses on water supply and use and describes the source, use, and disposition of water in each State, the District of Columbia, Puerto Rico, and the U.S. Virgin of Columbia, reletor kick, and the C.S. Virgini Islands. Each State summary contains an overview of water supply and use, including a simplified State water budget, a brief history of water-re-sources development in the State, a description of the major categories of water use and their geo-graphic distribution within the State, and a summary of water-use-management activities. Multicolor illustrations show the State's water budget; growth of reservoir storage; population distribution in 1985 and the historical growth of population; surface-water, groundwater, and total withdrawals by county; freshwater withdrawals by category of use and by principal river basins and aquifers; and the source, use and disposition of total freshwater withdrawals. Also summarized are the State agencies, laws, and regulations involved in the management of water supply and use. Other parts of the report provide a review of significant hydrologic events in the 1987 water year; describe trends and factors that affect domestic, industrial, and agricul-tural water use; review estimation techniques for determining instream-flow requirements; and discuss the benefits and capabilities of water-use forecast. (USGS) TRINIDAD RESERVOIR **OPERATIONS** POLICY DECISION SUPPORT SYSTEM. For primary bibliographic entry see Field 4A. W91-09576

### MODEL FOR SAVING RESOURCES. WRc Inc., Huntington, PA. For primary bibliographic entry see Field 5F. W91-09772

GROUND-WATER PUMPAGE FROM THE CO-LUMBIA PLATEAU REGIONAL AQUIFER SYSTEM, WASHINGTON, 1984. Geological Survey, Tacoma, WA. Water Re-

sources Div. D. R. Cline, and M. E. Knadle.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4135, 1990. 32p, 1 pl, 4 fig, 4 tab, 8 ref.

Descriptors: \*Columbia Plateau, \*Washington, \*Groundwater resources, \*Water use, Columbia River Basalt Group, Overburden, Pumping system efficiency, Electrical power consumption.

An inventory of groundwater pumpage, mostly for irrigation, on the Columbia Plateau in eastern Washington totaled about 680,000 acre-ft in 1984. Water is withdrawn from four water yielding units (three basalt and one overburden). Pumpage from the Grande Ronde unit (oldest basalt) totaled 205,000 acre-ft; the Wanapum unit, 270,000 acre-ft; the Saddle Mountains unit, 24,000 acre-ft; and the locally occurring overburden, 180,000 acre-ft.

Most of the pumpage from the overburden occurs
in Grant and Franklin Counties. Adams, Franklin, Grant, and Lincoln Counties accounted for threefourths of the total pumpage on the plateau. Three subareas in these counties accounted for threefourths of this pumpage: Odessa subarea, 212,000 acre-ft; Black Sands area, 95,000 acre-ft; and southern Franklin County, 75,000 acre-ft. Groundwater levels in the Odessa subarea have declined locally more than 100 ft. (USGS)

EVOLUTION OF NEVADA'S WATER LAWS AS RELATED TO THE DEVELOPMENT AND EVALUATION OF THE STATES WATER RESOURCES, FROM 1866 TO ABOUT 1960. Geological Survey, Carson City, NV. Water Re-For primary bibliographic entry see Field 6E. W91-09858

ROLE OF REMOTE SENSING IN IRRIGA-TION MANAGEMENT: A CASE STUDY ON ALLOCATION OF IRRIGATION WATER. For primary bibliographic entry see Field 7B. W91-10090

### WATER FOR THE FUTURE: HYDROLOGY IN PERSPECTIVE. For primary bibliographic entry see Field 2A. W91-10103

THREE STAGES OF WATER ECONOMY (LES TROIS STADES DE L'ECONOMIE DE L'EAU). Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 2A.
W91-10109

HYDROLOGY AND THE ENVIRONMENT: THE CASE STUDY OF SAO PAULO, BRAZIL. Sao Paulo Univ. (Brazil). Dept. de Hidraulica. R. M. Hermann, M. F. Amaral, and R. H. O. M.

In: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 171-178, 3 fig. 1 tab.

Descriptors: \*Brazil, \*Developing countries, \*Hydroelectric power, \*Multipurpose projects, \*Multipurpo

purpose reservoirs, \*Urban hydrology, \*Water resources management, Economic aspects, Metropolitan water management, Nonstructural alternatives, Wastewater treatment, Water quality management.

Water is tied closely to economic growth and development, in parallel with industrialization. To accomplish such close links, hydroelectricity is a must in developing countries. The present water resources system of the Sao Paulo metropolitan area was conceived in such a context and has evolved throughout the last 30 years. Consequently, multipurpose operation was ignored until very recently, when flood control, public well-being, and environmental concern have grown significantly and have become as important as hydroeleccantly and have become as important as hydroelectric power. But the situation has worsened so much that, while there is a willingness to improve the water quality in the nearby streams, the scarci-ty of monetary resources, which are required to construct sewage treatment plants, is a limiting construct sewage treatment plants, is a limiting factor to such goals. In order to overcome these economic problems, nonstructural measures are nowadays being seriously considered. These problems are typical of developing countries faced with rapidly expanding urban areas and will present the hydrologist with considerable difficulties for many verse to come (See also Well 1912) (Auction 1912). years to come. (See also W91-10103) (Author's abstract) W91-10120

#### TOWARDS EFFECTIVE FUTURE WATER RE-SOURCES POLICIES FOR SOCIO-ECONOMIC DEVELOPMENT IN AFRICA.

For primary bibliographic entry see Field 6E. W91-10131

#### WATER-RELATED CONSTRAINTS TO AFRI-CAN DEVELOPMENT IN THE NEXT FEW DECADES.

Swedish Natural Science Research Council, Stockholm.

M. Falkenmark

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 439-453, 4 fig, 1 tab, 32 ref.

Descriptors: \*Africa, \*Arid-zone hydrology, \*Developing countries, \*Limiting factors, \*Semiarid lands, \*Water demand, \*Water resources management, Climates, Human population, Irrigation requirements, Soil-water-plant relationships, Technology transfer, Water scarcity, Water shortage.

In overpopulated and water-deficient developing countries, it is fundamental for planners to undercountries, it is fundamental for planners to understand the hydrological conditions properly. The hydrological problems of semiarid Africa have been examined with respect to hydrological determinants of both length of growing season, and water availability for technical use in society. At the core of the examination is the extent interest. the core of the examination is the system interaction among man-vegetation-water-soil, the vicious among man-vegetation-water-soil, the vicious circle generated by multiplying populations, and man's vegetation-based interventions with crucial partitioning joints in the local hydrological cycle. Land productivity is a function of water availability, and a great number of third world countries are too dry to attain food self-availability. are too dry to attain food self-sufficiency within the present irrigation plans. Management con-straints due to water scarcity are aggravated by the facts that the hunger crescent passes through the hydrological border zone, and that population increase generates water scarcity problems. The pes-simistic outlook on the land productivity potential in Africa clearly indicates the fundamental importance of stopping further degradation of the re-source base. Major problems emerging from hy-drologically-defined natural constraints to the area are limited potential population supporting capacity, marginal hydrological conditions-creating great sensitivity to vegetation changes-and galloping water scarcity generated by population increase. The risk of climatic bias in transfer of knowledge from the temperate zone must be taken into account. (See also W91-10103) (Fish-PTT)

#### Water Law and Institutions—Group 6E

PROCEEDINGS OF: SOUTH TEXAS IRRIGATION CONFERENCE,

For primary bibliographic entry see Field 3F. W91-10445

STATUS AND TRENDS OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE SAN ANTONIO REGION,

SAN ANIJONIO REGION.

Southwest Texas State Univ., San Marcos.

G. Longley.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991.

p 4-18. 10 fig. 11 ref.

Descriptors: \*Aquifer characteristics, \*Edwards Descriptors: "Aquier characteristics, "Edwards aquifer, "Groundwater budget, "Groundwater management, "Trigation requirements, "Texas, "Water rescources management, Water use, Aquifer management, Conjunctive use, Future planing, Groundwater recession, Hydrologic models, Regional planning, San Antonio, Springs, Surfacegroundwater relations.

The Balcones Fault Zone Edwards Aquifer in the San Antonio region is one of the nine major aquifers in Texas and directly supplies drinking water to more than 1.3 million persons. Irrigated agriculture has used 196.2 thousand acre feet of water and an annual average of 357 thousand acre feet/year is supplied to downstream users in the river systems for all uses. Models of the aquifer have suggested that withdrawals should not regularly exceed 425 to 450 thousand acre feet/year, in order to maintain springflow at San Marcos and protect endangered species there. Analysis of the water budget for the region (1934 to 1989) shows that discharge approximately balances with re-The Balcones Fault Zone Edwards Aquifer in the that discharge approximately balances with re-charge. In order to maintain springflow, it is not possible to regularly allow discharge by pumping to approach the amounts of recharge. Augmenta-tion from nearby aquifers to solve the problem of lost springflow would allow groundwater quality degradation in some areas and introduce water having different characteristics into the spring en-vironment. A conservative drought analysis deter-mined that there is a 78% probability that recharge will be less than 229,000 acre feet at least once every 10 year period. The problem is compounded by the fact that the San Antonio region is one of that in order to manage the water resources of the region there should be a system of conjunctive management developed. Any management scheme will have to consider more efficient use of available supplies and reuse will have to become a reality for most users. (See also W91-10445) (Ver-Nooy-PTT) W91-10446

#### 6E. Water Law and Institutions

IMPROVING MANAGEMENT OF INTRA-STATE AND INTERSTATE WATER TRANS-FER IN THE EASTERN UNITED STATES. Virginia Polytechnic Inst. and State Univ., Blacks-burg, Dept. of Civil Engineering. W. E. Cox, and L. A. Shabman. Available from National Technical Information Service, Springfield, VA 22161 as PB91-136283/ AS. Price codes: A12 in paper copy; A12 in micro-fiche. Program Report, September 1990. 260p, 4 fig. 6 tab, 116 ref, 3 append. USGS Contract No. 14-08-0001-G1481.

Descriptors: \*Adminstrative agencies, \*Institu-tions, \*Water management, \*Water policy, \*Water rights, \*Water transfer, Environmental impact, In-terjurisdictional conflict, Negotiations, Social aspects, Water use efficiency

Transfer of water from areas of abundance to areas of scarcity has long been a basic water management tool, even in the eastern United States, but the increasing controversy over transfer is not resolved effectively by existing water management institutions. In addition, these institutions impede conflict-resolving negotiations among the affect parties by providing such obstacles as property-rights uncertainties. The report documents the

nature of the conflict-resolution process by means of case studies of successful and unsuccessful transfer proposals, including the areas of New York City, Southeastern Virginia and Boston. The characteristics of successful negotiations are described, and decision-making process is proposed to feciliacteristics of successful negotiations are described, and decision-making process is proposed to facili-tate negotiation while providing a backup arbitra-tion process to encourage good faith negotiations and prevent unnecessarily protracted conflict. The process promotes water process decision making that is sensitive to environmental concerns, effithat is sensitive to environmental concerns, effi-ciency in water use, and the equitable distribution of water transfer gains. Concerns over environ-mental and distributional impacts are addressed by provisions for compensation broader than tradi-tional arrangements. Alternative designs for ad-ministration of the proposed decision process are evaluated. Administrative options are presented for interstate transfer and then extended to the intrainterstate transfer and then extended to the intra-state situation by considering available institutional mechanisms for resolving interstate water use conflicts. (USGS) W91-09567

LOGICAL INTRANSITIVITIES AND OTHER ADMINISTRATIVE NIGHTMARES: CAN

LOGICAL INTRANSITIVITIES AND OTHER ADMINISTRATIVE NIGHTMARES: CAN MODELS HELP.
Hydrosphere, Boulder, CO.
C. M. Brendecke, and B. L. Harding.
IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 303-310. 4 fig, 3 ref.

Descriptors: \*Computer models, \*Computer programs, \*Model studies, \*Water law, \*Water management, \*Water rights, Administrative decisions, Data requirements, Decision making, Legal aspects, Technology transfer, Watershed manage-

State administration of water rights under the prior appropriation doctrine is an already complex task that becomes even more difficult when exchanges and subordination agreements are superimposed. The effective priorities of water rights exchanges I ne effective priorities of water rights exchanges are complicated functions of competing and calling priorities and the flows in intervening stream reaches. Selective subordination agreements, which reverse the relative priorities between two water rights, may imply priority orderings injurious to rights with intervening priorities. As these two types of water rights institutions come into increasing use, information requirements grown to increasing use, information requirements grow rapidly and the State's administrative resources are further stressed. Precise administrative resources are further stressed. Precise administration of selective subordinations, exchanges, and other complex water management agreements often require infor-mation which is not readily available or convenmatton which is not readily available or conveniently observed. Computer models could play a role in simplifying water rights administration in the face of their information requirements. In addition, models may be used to assist in the formulation of decrees for new water rights plans and to identify features of proposed plans which may be difficult to administer. (See also W91-09570) (Korn-PTT) W91-09601

LEGAL AND ECONOMIC DISINCENTIVES IN THE TRANSFER OF MODELS TO USERS. Hydrosphere, Boulder, CO. For primary bibliographic entry see Field 7C. W91-09604

TO TELL THE TRUTH-HYDROLOGIC MODELS IN COURT.

Oklahoma State Univ., Stillwater. Dept. of Agri-cultural Engineering. For primary bibliographic entry see Field 7C. W91-09605

STRATEGIES FOR ENVIRONMENTAL AS-SESSMENTS OF PROPERTY TRANSACTIONS. Geraghty and Miller, Inc., Annapolis, MD. For primary bibliographic entry see Field 5G. W91-09655

GROUNDWATER PROTECTION AND THE ROLE OF EDUCATION - AN APPRAISAL,

Virginia Polytechnic Inst. and State Univ., Blacks-

For primary bibliographic entry see Field 5G. W91-09656

COASTAL MANAGEMENT IN THE USSR: PERESTROIKA ON THE COAST.

Geographical Department, Moscow State University and Gomel Cooperative Institute, Byelorussia, USSR

V. S. Bondarenko.

Coastal Management CZMJBF, Vol. 18, No. 4, p 337-363, 1991. 2 fig, 1 tab, 19 ref.

Descriptors: \*Coastal waters, \*Coastal zone management, \*Coasts, \*USSR, \*Water resources management, Administration, Administrative regulations, Management planning, Operating policies.

The acuteness and variability of the problems encountered at the sea coasts of the USSR are without precedent, due to the huge stretch of coastline, variability of natural conditions, great differences in the density of population in coastal regions, the standards of the production forces, and economic specialization. It has been determined that the following seas have complete or considerable contamination of their basins: the Azov, the Baltic, the Black, the Caspian, the Aral, the Barents, the White, the Japan, and the Arctic Seas. As a whole, coastal management, as well as the entire system of regional management in the USSR, is charactercoasta management, as wen as the chure system or regional management in the USSR, is character-ized by administrative, branch (i.e., ministerial) management, the main features of which were established in the 1920s. This system is typically found in an economy based exclusively on state-owned land, natural resources, and means of production. The most popular commonly employed management strategies to achieve coastal manage-ment objectives are sectoral planning and national plans. Alternative concepts for restructuring coastal zone management are currently being devel-oped, including a step-by-step model for implemen-tation. This model will be similar to the free economic zone model, but will include extensive use of international experience of management as discussed in scholarly journals. The evolution of coastal management is, in general, in the second or third stage, i.e., growing awareness and national conferences and studies. Yet, because the USSR is such a large nation, some of the republics or re-gions are in stage 0 or 1 (no awareness or incipient awareness), whereas others are in stage 4a (revisions of existing programs such as regional plans, the Soviet analog of town and country planning). (Fish-PTT) W91-09694

ESTIMATION OF GROUNDWATER PROTEC-TION BENEFITS AND THEIR UTILIZATION BY LOCAL GOVERNMENT DECISION-MAKERS.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6B. W91-09825

REVIEW OF SELECTED WATER-MANAGE-MENT MODELS AND RESULTS OF SIMULA-TION OBSERVATIONS FOR THE TRUCKEE-CARSON RIVERS SYSTEM, CALIFORNIA AND NEVADA.

Geological Survey, Reston, VA. For primary bibliographic entry see Field 2E. W91-09849

EVOLUTION OF NEVADA'S WATER LAWS AS RELATED TO THE DEVELOPMENT AND EVALUATION OF THE STATE'S WATER RESOURCES, FROM 1866 TO ABOUT 1960.

Geological Survey, Carson City, NV. Water Resources Div.

H. A. Shamberger.

n. A. Statiloegra, Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. Nevada Water Resources Bulletin 46, 1991. 100p, 2 fig, 4 tab, 6 append, 27 ref.

#### Field 6-WATER RESOURCES PLANNING

#### Group 6E-Water Law and Institutions

Descriptors: \*Nevada, \*Water law, Carey Act, Groundwater, Pacific reclamation project, Surface water, Water resources development, History.

This report describes the evolution of surfacewater and groundwater law in Nevada, beginning in 1866 (2 years after statehood), and discusses the in 1866 (2 years after statchood), and discusses the problems confronted by the State Engineers in connection with the development of Nevada's water resources from 1903, when that office was created. The programs of stream gaging and groundwater studies by the U.S. Geological Survey in cooperation with the office of the State Engineer are discussed from the State perspective. The Carey Act and its application to the reclamation of desert lands in Nevada is also discussed. (Thacker, ISGS) (Thacker-USGS) W91-09858

## LIABILITY ISSUES IN GROUNDWATER QUALITY PROTECTION.

T. A. Feitshans. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 211-215, 1990. 12 ref.

Descriptors: \*Agricultural practices, \*Groundwater pollution, \*Groundwater protection, \*Liability, \*Water pollution prevention, Cleanup, Environmental audits, Environmental protection, Groundwater quality, Legislation, Water law, Water policy.

Over the past two decades, both federal and state governments have enacted much legislation affecting liability for contamination of groundwater. However, neither the states nor the federal government has developed comprehensive approaches to groundwater protection. Given the confusion and ment has developed comprehensive approaches to groundwater protection. Given the confusion and complexity in the law, it is difficult for agricultural producers to assess whether they will be found liable for acts that contaminate groundwater. Therefore, minimizing the likelihood that groundwater contamination will occur is the best strategy for avoiding liability. Merely complying with all existing law and regulations is no longer enough. Future legislation may impose cleanup liability for contamination resulting from activities that were entirely legal at the time they occurred. Careful evaluation through an environmental audit of all entirely legal at the time they occurred. Careful evaluation through an environmental audit of all activities is an excellent way to identify practices that may generate liability. Use of such audits, along with appropriate follow-up and corrective action, can greatly reduce the potential for civil liability and eliminate virtually all potential for criminal liability. (Author's abstract) W91-09874

#### BLAMELESS CONTAMINATION: NEW STATE LEGISLATION REGULATING LIABII FOR AGRICULTURAL CHEMICALS GROUNDWATER. LIABILITY

Georgia Agricultural Experiment Stations, Athens T. J. Centner.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 216-220, 1990. 2 fig, 1 tab, 50 ref.

Descriptors: \*Agricultural chemicals, \*Environmental law, \*Groundwater pollution, \*Legal aspects, \*Legislation, \*Liability, \*Path of pollutants, Agricultural runoff, Compensation, Fertilizers, Negligence, Pesticides, State jurisdiction.

Blameless contamination denotes limited situations in which contamination is caused by the normal and approved use of chemicals on plants and aniand approved use of circinata on plants and am-mals. Blameless contamination in agriculture does not include the following: spills and accidents, use of experimental or nonregistered chemicals; use of a chemical after registration has been canceled, at too high a concentration, on an unapproved crop or in an unapproved manner, at the wrong time or wrong season, more frequently than recommend-ed, by persons not trained or licensed for its use, for nonagricultural industrial or manufacturing uses, or contrary to acceptable agricultural practices. In more than 30 states, agricultural producers applying chemicals that contaminate groundwater may be held liable under a strict liability standard. Agricultural producers in every state, including those that adopted new legislation, can be liable for agricultural contamination due to negligence. A groundwater exemption law modifying strict liability and incorporating a victim-compensation fund is a promising response to the problem of damages. Provisions limiting the liability exemption would insure producers against blameless damages yet would not provide any real reason to increase contamination. The victim-compensation fund would provide innocent victims a practical procedure for securing compensation for contamination injuries and for dispensing monies for monitoring, testing, remedial actions and restitution. (Feder-testing, remedial actions and restitution. testing, remedial actions and restitution. (Feder-PTT)
W91-09875

#### FARMER LIABILITY FOR PESTICIDE CONTAMINATION OF GROUNDWATER IN CONTAMINATION NECTICUT.

ecticut Univ., Storrs. Dept. of Agricultural and Resource Economics.

L. K. Lee, and R. L. Leonard.

Journal of Soil and Water Conservation JSWCA3,

Vol. 45, No. 2, p 221-222, 1990. 3 ref.

Descriptors: \*Agricultural chemicals, \*Connecticut, "Groundwater pollution, "Liability, "Non-point pollution sources, "Pesticides, "Water pollu-tion sources, Compliance, Drinking water, Legal aspects, Legislation, State jurisdiction, Water pollution control.

The 1988 Connecticut General Assembly enacted Public Act 88-211, which provides farmers with some protection from the financial obligations of pesticide contamination of groundwater under the 1982 Potable Water Act. Public Act 88-211 does not limit any right of action by an individual for injury to person or property, but it does specify that a person whose pesticide use has caused or can reasonably be expected to cause groundwater polution shall be exempted from the Potable Water Act if that person: (1) properly applied the pesticide or arranged for a properly performed pesticide application; (2) was engaged in agriculture at the time the pesticide was used solely in the production of agricultural commodities; (3) has agreed to implement a plan to minimize groundwater contamination due to the storage, handling or disposal of pesticides; and (4) The 1988 Connecticut General Assembly enacted storage, handling or disposal of pesticides; and (4) has maintained pesticide use records and a plan to minimize groundwater contamination due to pesti-cide usage as specified in the law. Compliance by cade usage as specified in the law. Compinance by farmers is strictly voluntary. The law applies to pesticide groundwater pollution discovered on or after July 1, 1989. Although compliance with the 1988 rules may exempt farmers from supplying potable water to affected households, the exemppotable water to affected households, the exemp-tion does not limit private lawsuits against farmers for personal or property damages occurring from pesticide contamination of groundwater. Under the doctrine of strict liability, the Connecticut Depart-ment of Environmental Protection maintains that farmers as chemical users are responsible parties who can be held accountable for their actions if not in full compliance with the 1988 legislation. (Feder-PTT) 91-09876

## ENVIRONMENTAL REGULATION OF AGRI-

CULTURE IN ARIZONA.

Arizona Dept. of Environmental Quality, Phoenix.

For primary bibliographic entry see Field 5G.

W91-09884

#### CASE STUDIES IN RURAL GROUNDWATER MANAGEMENT. Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Dept. of Agricultural Economics. For primary bibliographic entry see Field 2E. W91-09886

## CLARKE COUNTY, VIRGINIA'S INNOVATIVE RESPONSE TO GROUNDWATER PROTEC-

Clarke County, Berryville, Virginia 22611-0169. For primary bibliographic entry see Field 5G. W91-09887

## COOPERATION AS A POLICY INITIATIVE IN

Utah State Univ., Logan. Dept. of Agricultural For primary bibliographic entry see Field 5G. W91-09889

## SPECIAL PROTECTION AREAS: A NEW NON-POINT-SOURCE MANAGEMENT OPTION IN

Nebraska Dept. of Environmental Control, Lin-coln. Ground Water Section. For primary bibliographic entry see Field 5G. W91-09890

#### IMPLEMENTATION ISSUES IN SPECIAL GROUNDWATER QUALITY PROTECTION AREAS.

Nebraska Univ., Lincoln. Dept. of Agricultural Economics. For primary bibliographic entry see Field 5G. W91-09891

## MICHIGAN GROUNDWATER SURVEY: A CO-OPERATIVE VENTURE OF LOCAL GOVERN-

Western Michigan Univ. Kalamazoo, Science for

Citizens Center D I Brown

D. J. Brown. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 268-269, 1990. 19 ref.

Descriptors: \*Groundwater resources, \*Information systems, \*Interagency cooperation, \*Local governments, \*Michigan, \*Surveys, Baseline studies, Geological data, Groundwater data, Land use, Management planning.

The Michigan groundwater survey focused on the design and implementation of a computerized groundwater and geologic information management system. Thousands of well logs stored as paper copy in local health departments were constitutional and accessible abstraction data files. County verted into accessible electronic data files. County-wide baseline groundwater quality studies focusing wells carefully chosen to characterize the ifers in each county were designed and executed. Having computer accessible information avail-able has allowed state and local agencies to better discharge their traditional responsibilities and to undertake new management activities. These range undertake new management activities. These range from well and septic system permitting and inspection to land use planning, zoning and groundwater management and protection. Baseline water quality can now be compared to new analyses to assess the degree of degradation in cases of possible contamination and preliminary site assessments can be performed with relative ease. Proposed new land uses can be evaluated more readily for their potential impact on groundwater quality. (Feder-PTT) W91-09894

#### LOCAL GOVERNMENTS COOPERATING TO PROTECT GROUNDWATER.

Minnesota State Planning Agency, St. Paul. For primary bibliographic entry see Field 5G. W91-09895

## COORDINATED GROUNDWATER PROTECTION IN HEBRON, CONNECTICUT.

Connecticut Dept. of Environmental Protection, Hartford. Bureau of Water Management. For primary bibliographic entry see Field 5G. W91-09897

# STORMWATER RUNOFF POLICY ON THE SPOKANE/RATHDRUM PRAIRIE AQUIFER. Panhandle Health District 1, Coeur d'Alene, ID. For primary bibliographic entry see Field 5G. W91-09898

### LOCAL LAND USE PLANNING FOR RURAL GROUNDWATER PROTECTION IN VER-MONT AND NORTHERN NEW YORK, Vermont Univ., Burlington. School of Natural Re-

sources

For primary bibliographic entry see Field 5G.

W91-09901

WATER RESOURCES COMPUTER SOFT-WARE: THE FIRST PARTY AND THIRD PARTY LIABILITY OF THE LICENSEE AND

Davis and DiGrazia, Laguna Hills, California W. E. Davis.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A27-A33. 20

Descriptors: \*Computer programs, \*Contracts, \*Data processing, \*Legal aspects, Liability, Licensing, Torts.

As part of every contract, whether written or oral, are duties which may give rise to liability to one of the parties. Although there are no court rulings at the present time, a preparer of software could be held liable under the general guidelines of Tort Law. Therefore, the preparer of software should be totally aware of what the software is going to be used for so proper disclaimers and limited war-ranties can be made. The preparer should also appreciate the risk to which he/she is being exappreciate the risk to which he/she is being exposed. Designers of special purpose software may need assurance that the software will be used only as intended, and should disclaim any misuse of the software. All persons writing software must be cognizant of the fact that this area is ripe for major litigation, and it will commence in the not too distant future. (See also W91-10018) (Korn-PTT) W01-10028. W91-10025

## AMERICAN RIVERS GUIDE TO WILD AND SCENIC RIVER DESIGNATION: A PRIMER ON NATIONAL RIVER CONSERVATION.

American Rivers, Inc., Washington, DC. For primary bibliographic entry see Field 2E. W91-10064

## TOWARDS EFFECTIVE FUTURE WATER RE-SOURCES POLICIES FOR SOCIO-ECONOMIC DEVELOPMENT IN AFRICA.

DEVELORMENT IN AFRICA.

K. A. Tuffuor.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 289-298, 1 tab, 5 ref.

Descriptors: \*Africa, \*Developing countries, \*Economic development, \*Fuiure planning, \*Social aspects, \*Water demand, \*Water manage-ment, \*Water policy, \*Water resources manage-ment, Administrative agencies, Financial aspects, Institutions, Organizations, Research priorities, Water quality management, Water resources devel-

In Africa, water availability in the right quantity and quality for human survival has been elusive, in great part because of droughts, floods, and encroaching deserts. Inadequate nationally committed and implemented policies on the use and constant of the property of t ted and implemented policies on the use and con-trol of water resources; lack of support for appro-priate research for development; lack of continuity in project operations due to inability to meet recur-rent and operations and maintenance costs; con-flicts and frequent changes in national priorities; inadequate interactions between decision makers, planners, researchers, and educationalists; and lack of properly trained professionals including manag-ers are some of the basic elements militating against water resources development. Education, training, and research programs and the organizatraining, and research programs and the organiza-tion and reorganization of national water resources institutions, agencies, and councils need to be examined to enable them to meet the future challenges and problems in data and information gathreing and dissemination on water resources (quantity and quality), effects of increasing population, financial constraints (local and foreign), environmental degradation, local and interbasin water needs and availability, and avoidance in the wastes and duplications in studies and research for devel-opment. (See also W91-10103) (Author's abstract) W91-10131

FUTURE FOR OPERATIONAL HYDROLO-GY-A WMO PERSPECTIVE. World Meteorological Organization, Geneva (Switzerland).

(SWIZEFIANG). IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 299-310, 1 tab.

Descriptors: \*Future planning, \*Hydrology, \*Interagency cooperation, \*International commissions, \*Planning, \*Technology transfer, \*Water resources institutes, Commissions, Government supports, Hydrologic data, Meteorology, Operating policies, Organizations, United Nations, Water resources development, Water resources manage-

The Hydrology and Water Resources Program of the World Meteorological Organization (WMO) is based on the WMO's responsibilities in the field of operational hydrology. The program includes a well-established system for the organized transfer of hydrological technology between countries, called the Hydrological Operational Multipurpose System (HOMS). The Operational Mydrology Programme (OHP) provides the basis and framework for all the scientific and technical aspects of WMO's activities in operational hydrology, and its structure includes: institutional cooperation of Hydrological Services, standardization and regulators drological Services, standardization and regulatory activities, hydrological networks and instrumentaactivities, hydrological networks and instrumenta-tion, data collection and processing, computation of hydrological data for water resource projects, and hydrological forecasting. Plans of varying detail are laid up to ten years in advance. These offer guidance not only for the WMO's Secretariat but also for national agencies which are involved in international activities in operational hydrology. The Cooperation with Water-related Programmes of Other International Organizations during the of Other International Organizations during the next decade will encourage the further develop-ment and use of internationally agreed terminology in the field of hydrology and water resources, ensure appropriate contributions by WMO in the field of operational hydrology to the activities of other UN agencies, and encourage and assist inter-national river basin authorities and nongovernmen-tal international organizations in their work related national river basin authorities and nongovernmental international organizations in their work related to operational hydrology. These plans have many opportunities and possible technological developments in the future. Inputs by nongovernmental awell as by governmental organizations can be most helpful for WMO in identifying future trends in this regard. (See also W91-10103) (Author's abstract) stract) W91-10132

# EVOLUTION OF PUBLIC POLICY WITH REGARD TO THE ENVIRONMENT: A LEGAL PERSPECTIVE OVER THE LAST FIFTY

Stellenbosch Univ. (South Africa). Faculty of

M. A. Rabie, and J. I. Glazewski. South African Journal of Science SAJSAR, Vol. 86, No. 7-10, p 413-418, July/October 1990. 36 ref.

Descriptors: \*Environmental law, \*Environmental policy, \*History, \*Legislation, \*Public policy, \*South Africa, Catchment areas, Federal legislation, Marine pollution, Mountain Catchment Areas Act, Water Act, Water pollution prevention.

A survey of official and unofficial sources of gov-A survey of official and unofficial sources of government public policy showed that environmental public policy is reflected chiefly in legislation. A review of South African environmental legislation from the seventeenth century to the present day reveals a progressive development in the ambitiousness and scope of the country's environmental legislation. By contrast, judicial environmental law-making is scant. Environmental legislation has evolved as a rescitor to particular sectional interevolved as a reaction to particular sectional inter-ests and concerns, rather than as a result of an cess and concerns, father than as a result of an overall environmental policy or strategy. The promulgation of the Mountain Catchment Areas Act 63 of 1970 was the first substantial legislation aimed at mountain conservation. Besides traditional legislation pertaining to living marine resources, additional legislation has been enacted. The Water Act of 1956 remains the most important legislation

for the control of freshwater pollution and of marine pollution from land-based sources. The declaration of actual environmental policies, provided for in the Environment Conservation Act 73 of 1989 could play a significant role in redressing this imbalance and could set the scene for environmental law-making at the judicial level. (Brunone-W91-10187

#### LEGAL CONTROL OF POLLUTION.

Imperial Coll. of Science and Technology, London (England). Centre for Environmental Technology. R. Macrory.

In: Pollution: Causes, Effects and Control. Royal Society of Chemistry, Cambridge, England. 1990. p 277-296.

Descriptors: \*Air pollution control, \*England, \*Environmental law, \*Environmental protection, \*Legal aspects, \*Social change, \*Water pollution control, Enforcement, History, Land disposal, Legislation, Standards, Waste disposal.

Pollution laws are both complex and dynamic, and the present decade has seen British law in this field subjected to a series of important changes. The history of these changes and current approaches to pollution law has been reviewed. Major topics covered include: (1) sources of law; (2) underlying characteristics of British pollution laws; (3) waste disposal on land including the control framework, site-licensing, tracking systems, imports and exports of wastes, and enforcement of consistent standards; (4) industrial air pollution which involves prescribed classes of works, clean air acts, and legislation and future directions; (5) water pollution; and (6) recent trends in pollution legislaponution, and of recent ureas in ponution legisla-tion including public involvement, land-use plan-ning and pollution control, and integrated pollu-tion control. British pollution laws have for over a century remained fairly static in their underlying structure. However, recent years have seen a rare series of fundamental reappraisals, emerging from both national and international pressures, which have challenged well-established and familiar ap-proaches. (See also W91-10406) (White-Reimer-PTT) W91-10418

## PESTICIDES AND THE GROUND WATER CONNECTION.

Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5G.
W91-10425

## WISCONSIN'S GROUNDWATER MONITOR-ING PROGRAM FOR PESTICIDES.

For primary bibliographic entry see Field 5A.

#### WISCONSIN'S GROUNDWATER PUBLIC HEALTH IMPACTS AND ENFORCE-

Wisconsin Dept. of Agriculture, Madison. Trade and Consumer Protection. For primary bibliographic entry see Field 5G. W91-10438

#### SOME EXAMPLES OF ES-USDA GROUND-WATER QUALITY PROGRAMS: 'NEW TOOLS FOR LOCAL GOVERNMENT'.

For primary bibliographic entry see Field 5G.

## NEW TEXAS WATER PLAN: IMPLICATIONS FOR IRRIGATED AGRICULTURE.

Texas Water Development Board, Austin. For primary bibliographic entry see Field 6B. W91-10447

#### Field 6-WATER RESOURCES PLANNING

#### Group 6F-Nonstructural Alternatives

#### 6F. Nonstructural Alternatives

ELARC: HYDROLOGIC FORECASTING FOR FLOODPLAIN MANAGEMENT WITHIN THE POTOMAC RIVER BASIN--PHASE I, National Weather Service, Harrisburg, PA. W. B. Reed, S. S. Schwartz, and R. S.

Hammerschlag.

IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 209-217. 4 fig, 4 ref.

Descriptors: \*Computer models, \*Flood forecasting, \*Flood plain management, \*Model studies, \*Nonstructural alternatives, \*Streamflow data, \*Warning systems, Automation, Computer programs, Computers, Data acquisition, ELARC, Gaging stations, River forecasting, Technology transfer

The Enhanced Limited Automatic Remote Collection (ELARC) system is a microcomputer-based hydrologic forecasting system that uses real-time streamflow data retrieved by telephone line from upstream data loggers. The ELARC system generates a computer screen displayed report, including a hydrograph for the Chesapeake and Ohio Canal National Historical Park by the Interstate Commission on the Potomac River Basin in conjunction with the National Weather Service and the National Park Service. The system is being implemented by the National Park Service in two phases. Phase 1 forecasts flows which can result in drownings in the vicinity of the Great Falls of the Potomac. Since the majority of these deaths occur when the Potomac River stage is below bankfull, the system was designed to forecast subtle changes in the corresponding flows. Phase 2 will require system refinements to forecast flood flows that necessitate management actions to protect park structures. (See also W91-09570) (Author's abstract) W91-09570) (Author's abstract)

PLANNING AND LEGAL RESPONSES TO SEA-LEVEL RISE IN SOUTH AFRICA. Cape Town Univ. (South Africa). Dept. of Environmental and Geographical Science. For primary bibliographic entry see Field 2L. W91-10180

#### 6G. Ecologic Impact Of Water Development

EFFECTS OF WEIR MANAGEMENT ON MARSH LOSS, MARSH ISLAND, LOUISIANA,

USA: Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries. For primary bibliographic entry see Field 2L. W91-09367

ESTIMATED WATER-QUALITY CONDITIONS AND POTENTIAL DOWNSTREAM CHANNEL EFFECTS OF THE PROPOSED ROCK CREEK AND WOLFORD MOUNTAIN RESERVOIRS, NORTH CENTRAL COLORADO.
Geological Survey, Grand Junction, CO. Water

Geological Survey, Grand Junction, CO. Water Resources Div. For primary bibliographic entry see Field 2H. W91-09491

SIMULATION OF THE EFFECTS OF GROUND-WATER WITHDRAWAL FROM A WELL FIELD ADJACENT TO THE RIO GRANDE, SANTA FE COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div.

Sources Liv.

D. P. McAda.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS

Water-Resources Investigations Report 89-4184, 1990. 27p, 23 fig. 11 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Pumpage, \*Streamflow depletion, \*Surface-

groundwater relations, \*Withdrawal, Computer models, Groundwater recharge.

An existing three-dimensional groundwater flow model developed for the Santa Fe area was used to demonstrate the use of a basinwide model to evaluate the effects of groundwater withdrawal from wells on flow in nearby rivers. Model simulations of groundwater withdrawal from the Buckman well field were made in order to estimate the effects on flow in the Rio Grande, Pojoaque River, and Rio Tesuque. A simulation of historical withdrawal from the well field from 1972 to 1986 indicated streamflow capture for the same time period of 8,450 acre-ft. (36% of withdrawal) from the Rio Grande and 112 acre-ft (0.5% of withdrawal) from the Pojoaque River. A series of simulations that used hypothetical withdrawals from specific wells in the Buckman well field is presented to illustrate the effects of withdrawal from those wells on the rivers. When particular wells were assumed to withdraw 1,000 acre-ft of water for 1 year, the simulated cumulative streamflow capture was 40 to 64% of withdrawal after 21 o36 years from the Rio Grande and was 6.6 to 7.2% of withdrawal after 2.4 to 3 years from the Pojoaque River, depending upon which wells were pumped. When the well field was assumed to withdraw 2,500 acre-ft of water/yr continuously, the simulated annual streamflow capture after 100 years, as a percentage of annual groundwater withdrawal, was 74% from the Rio Grande, 2.8% from the Pojoaque River, and 1.2% from the Rio Tesuque. (USGS)

PREDICTING IMPACTS OF SUBDIVISION DEVELOPMENT IN LOUDOUN COUNTY, VIRGINIA.

GeoTrans, Inc., Herndon, VA. For primary bibliographic entry see Field 5B. W91-09646

CURRENT ISSUES IN ENVIRONMENTAL MANAGEMENT: A CASE STUDY OF SOUTH-ERN CALIFORNIA'S MARINE MONITORING SYSTEM.

Conservation Foundation, Washington, DC. For primary bibliographic entry see Field 5G. W91-09697

COASTAL ZONE TOURISM: A POTENT FORCE AFFECTING ENVIRONMENT AND SOCIETY

Washington Univ., Seattle. Inst. for Marine Stud-

M. L. Miller, and J. Auyong. Marine Policy MAPODG, Vol. 15, No. 2, p 75-99, March 1991. 1 fig, 15 tab.

Descriptors: "Coastal environment, "Coastal zone management, "Coastal zone tourism, "Environmental effects, "Tourism, "Urbanization, Environmental policy, Land use, Public participation, Recreation, Recreational facilities, Regional development, Research priorities.

As experiences in the popular parts of the Mediterranean, the Caribbean, and the Pacific have shown, coastal and marine tourism, have potential to transform the natural environment and society quickly and permanently. The construction and operation of hotels, airports, and marinas fundamentally alter the coastal environment and displace communities. For tourism to be acceptable, it is necessary to ensure that the full implications of development for natural ecosystems be articulated. The reasoning behind the ideas of sustainable tourism development, tourism planning, and social, or eco-tourism, is that the susceptibility of nature and human groups can be documented. Scientific results can play a role in the selection of the most appropriate implementation strategies. Extensive documentation of world tourism patterns, as well as the existence of the World Tourism Organization of the United Nations, suggest that tourism is a major stimulus on the world scene. Research is needed to ensure: (1) the implementation of environmental and socioeconomic monitoring programs; (2) the refinement of acceptable tourism development

models; (3) the establishment and protection of parks, sanctuaries, and biosphere reserves; (4) the promotion of local community participation in the planning of appropriate tourism development; and (5) the creation of interpretive education and ecotourism programs to foster responsible tourism citizenship. (Doria-PTT) W91-09755

BIOECONOMIC ANALYSIS OF WATER ALLOCATIONS AND FISH HABITAT ENHANCE-MENTS, JOHN DAY BASIN, OREGON.

Oregon State Univ., Corvallis. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 6B.

SIMULATION OF GROUND-WATER FLOW AND POTENTIAL LAND SUBSIDENCE, AVRA VALLEY, ARIZONA.

Geological Survey, Tucson, AZ. Water Resources Div

For primary bibliographic entry see Field 2F. W91-09847

CHANGES IN ICHTHYOFAUNAL DIVERSITY AND ABUNDANCE WITHIN THE MBASHE ESTUARY, TRANSKEI, FOLLOWING CON-STRUCTION OF A RIVER BARRAGE.

Transkei Univ., Umtata (South Africa). Dept. of Zoology. E. E. Plumstead.

South African Journal of Marine Science SJMSE7, Vol. 9, p 399-407, 1990. fig, 1 tab, 39 ref.

Descriptors: \*Dams, \*Ecological effects, \*Fish populations, \*Mbashe Estuary, \*Species diversity, Estuaries, Floods, Gill nets, Sediment load, South Africa, Suspended sediments, Water resources development.

A three-year gill net survey of ichthyofauna in the Mbashe Estuary, south Africa, conducted between 1980 and 1982 prior to the construction of a barrage on the river in 1984, was repeated during the period 1985 to 1988. The mean number of species caught per month, the mean total abundance of fish, and the mean abundance of Mugil cephalus per sample decreased significantly after the construction of the barrage. The later period was characterized by high rainfall, but no significant changes in salinity or transparency were recorded. The decline in the total abundance of fish, and in M. cephalus in particular, may have occurred as a result of a depleted food web caused by: (1) the removal of silt and organic matter from the Mbashe Estuary during a severe flood in February 1985; (2) the subsequent lack of replenishment as a result of retention of most of the suspended materially the barrage; and (3) the continued sediment scour of successive but less severe floods during the following years. (Author's abstract) W91-10013

THREE STAGES OF WATER ECONOMY (LES TROIS STADES DE L'ECONOMIE DE L'EAU). Bureau de Recherches Geologiques et Minieres, Orleans (France).

For primary bibliographic entry see Field 2A. W91-10109

INLET OF ALKALINE RIVER WATER INTO PEATY LOWLANDS: EFFECTS ON WATER QUALITY AND STRATIOTES ALOIDES L. STANDS.

Katholieke Univ. Nijmegen (Netherlands). Dept. of Aquatic Ecology and Biogeology. For primary bibliographic entry see Field 2H. W91-10165

UTILIZATION AND CONSERVATION OF EURYALE FEROX SALISBURY IN MITHILA (NORTH BIHAR), INDIA.

(NORTH BIHAR), INDIA.

Department of Botany, C. M. Science College,
Darbhanga-846 004, Bihar, India.

For primary bibliographic entry see Field 2H.

#### Network Design-Group 7A

W91-10166

#### 7. RESOURCES DATA

#### 7A. Network Design

GIS PROVING GROUNDS FOR WATER RE-SOURCES RESEARCH.
Purdue Univ., Lafayette, IN. Water Resources Re-

Purdue Univ., Lafayette, IN. water Resources Research Center.
J. R. Wright, and K. A. Buehler.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-111526/AS. Price codes: A04 in paper copy, A01 in microfiche. Technical Report 189, June 1990. 67p., 76, 5 tab, 46 ref, 2 append. USGS Contract No. 14-08-0001-G1561. USGS Project No. G1561-05.

Descriptors: \*Conflict management, \*Data analysis, \*Decision models, \*Geographical information systems, \*Systems engineering, Computers, Data storage and retrieval, Groundwater management, Planning, Resource planning, Watershed informations.

Spatial decision support systems (SDSS) are analytical systems used to address management problems that are ill-defined and that have domains or lems that are ill-defined and that have domains or solution spaces that have a spatial dimension. Spatial data domains are popularly managed by the emerging technology of geographical information systems (GIS). The purpose of this research is to demonstrate how the thoughtful integration of GIS and expert systems technologies can result in an SDSS that is useful in managing land and water resources. A central feature of this research is the use of modern systems prototyping tools to facilitate the rapid and efficient development of the SDSS. (Wright-IN WRRC) W91-09468

AVAILABILITY AND SUITABILITY OF MUNICIPAL WASTEWATER INFORMATION FOR USE IN A NATIONAL WATER-QUALITY ASSESSMENT: A CASE STUDY OF THE UPPER ILLINOIS RIVER BASIN IN ILLINOIS, INDIANA, AND WISCONSIN.
Geological Survey, Urbana, IL. Water Resources

Div.

For primary bibliographic entry see Field 5A. W91-09485

APPROACH TO THE RATIONALIZATION OF STREAMFLOW DATA COLLECTION NET-WORKS.

Manitoba Univ., Winnipeg. Dept. of Civil Engi-

neering.
D. H. Burn, and I. C. Goulter.
Journal of Hydrology JHYDA7, Vol. 122, p 71-91,
January 1991. 4 fig, 5 tab, 17 ref.

Descriptors: \*Data acquisition, \*Gaging stations, \*Manitoba, \*Mathematical studies, \*Network design, \*Stream gaging, \*Streamflow data, Cluster analysis, Hydrology, Networks.

A new procedure for rationalizing a streamflow data collection network is developed. The proce-dure is a two-phase approach in which in the first phase, a hierarchical clustering technique is used to identify groups of similar gaging stations. In the second phase, a single station from each identified second phase, a single station from each identified cluster of gaging stations is selected to be retained in the rationalized network. The station selection phase is an inherently heuristic process that incorporates information about the characteristics of the individual stations in the network. The methodology allows the direct inclusion of user judgement into the station selection process in that it is possinto the station selection process in that it is possible to select more than one station from a group, if conditions warrant. The technique is demonstrated using streamflow gaging stations in and near Pembina River Basin, southern Manitoba, Canada. The demonstration example shows the clarity of the demonstration example shows the charty of the results obtained from the approach and ease with which the approach can be used in rationalizing a hydrometric network. The example application also shows how the approach can adjust to different requirements for the retained data collection

network through altered emphasis on the components of the station pair similarity measure. (Agostine-PTT) W91-09737

COLLECTING FIELD DATA FOR A HYDRAU-LIC MODEL.

GRW Engineers, Lexington, KY

B. Montgomery. Water Engineering and Management WENMD2, Vol 138, No. 2, p 19, 22-23, February 1991. 1 fig, 4

Descriptors: \*Calibrations, \*Computer models, \*Data acquisition, \*Model studies, \*Model testing, \*Water distribution, Flow, Hydrants, Inspection, Measuring instruments, Pipes, Pumps, Utilities, Valves, Water metering, Water pressure, Water

In order to have a valid computer hydraulic model, actual field data must be collected and used to insure accurate depictions of the operation of the distribution system. The utility should be ac-tively involved in the collection of this data and should be familiar with its use in the computer should be familiar with its use in the computer model. An organized, systematic approach assists in the management of data. To verify hydraulic pressures, 24-hour or 7-day pressure chart recorders should be placed at key locations. To acquire water usage data, water billing data is typically available by meter reading routes each month. It may be desirable to develop 'field' pump curves describing the head versus flow operating range for the pumps in the system. The physical condition of the pipes must also be determined, based on a representative sample of pipe. To be truly calibrated, the model should be able to predict pressures and flows under a wide range of operating conditions. One method is to artificially induce fire flows by performing hydrant flow tests at strategically located hydrants in the system. To accurately determine boundary conditions for the model, the downstream setting of the pressure reducing valves downstream setting of the pressure reducing valves must be field-verified. After collecting appropriate calibration data, it must be incorporated into the model. Then the results should be compared to the field-collected pressures and flow rates. (Doria-PTT) W91-09773

EVALUATION AND DESIGN OF GEOPHYSI-CAL MONITORING NETWORK FOR GROUNDWATER CONTAMINATION.

Nebraska Univ.-Lincoln. Dept. of Civil Engineer-

Available from National Technical Information Service, Springfield, VA 22161 as PB91-162842. Price codes: A14 in paper copy; A02 in microfiche. Final Report, 1990. 298p, 20 tab, 45 ref, append. USGS Contract No. 14-08-0001-G1503.

Descriptors: \*Groundwater pollution, \*Data collections, \*Aquifer restoration, \*Kriging, \*Groundwater monitoring, \*Geophysical methods, \*Network design, Rhode Island, Spatial variation, Decision making, Variograms, Borehole data.

ndwater contamination has emerged as one of the Nation's primary environmental concerns. Re-liable, rapid and cost-effective detection and remedial action can contribute to minimizing the adverse environmental and economic impacts of groundwater contamination. This report contributes to aquifer remediation by developing a set of planning tools for detection, mapping, monitoring and remediation of contaminated aquifers. The report is divided into three main sections that correspond to a typical sequence of actions result-ing in a final remedial action plan for handling ing in a final remedia action plan to succeed contamination at a particular site. The first section develops a methodology for detecting and mapping suspected contamination using multiple develops a methodology for detecting and map-ping suspected contamination using multiple sources of data. Different data types are combined by using a modified form of kriging with uncertain data, termed compound kriging. In addition, the use of fuzzy set theory merged with geostatistics is explored as a possible mapping technique when variogram parameters are difficult to quantify. A decision support system for observation network design is resented in the second section. Network design is presented in the second section. Network

design is approached from a multiple objective decision making perspective. The objective is to identify the preferred network design while con-sidering the trade-off between performance and cost. Geostatistical variance reduction analysis and prior knowledge related to the site are used as performance measures in the decision support system. A remedial action design support system is described in the third section. Three dimensional geostatistical simulation and analytical groundwat-er modeling are used to assess the need for further remedial action planning. In addition, a methodology for measuring the performance of candidate remediation systems under conditions of uncertainremediation systems under conditions of uncertain-ty in aquifer parameters and plume location is presented. These performance measures, combined with cost factors, are used in a multiple-criteria decision making system to determine the preferred clean up system for a site being investigated. Each of the methods developed in this report have been demonstrated using data collected from the site of a low-level radioactive industrial waste reprocess-ing facility near Wood River Junction, Rhode Island. (Woldt-U. NE-Lincoln) W91-09861

SAMPLING STRATEGIES FOR ASSESSING HYDRAULIC CONDUCTIVITY AND WATER-CONDUCTING VOIDS IN SAPROLITE.

North Carolina State Univ., Raleigh. Dept. of Soil

For primary bibliographic entry see Field 5E. W91-09966

AMERICAN RIVERS GUIDE TO WILD AND SCENIC RIVER DESIGNATION: A PRIMER ON NATIONAL RIVER CONSERVATION. American Rivers, Inc., Washington, DC.

For primary bibliographic entry see Field 2E. W91-10064

INSTITUTIONAL ASPECTS OF REMOTE SENSING AND ENVIRONMENTAL DATA MANAGEMENT ISSUES AND RECOMMEN-DATIONS.

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div.

For primary bibliographic entry see Field 7B. W91-10101

WATER FOR THE FUTURE: HYDROLOGY IN PERSPECTIVE.

For primary bibliographic entry see Field 2A. W91-10103

HYDROLOGICAL NETWORK BASED ON AN INSTRUMENT FOR AUTOMATIC TIME-VARIABLE DATA ACQUISITION. Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.

Inc. Harding and T. Zeyringer.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 143-150, 3 fig, 7 ref.

Descriptors: \*Data acquisition, \*Hydrologic data collections, \*Hydrologic models, \*Model studies, \*Network design, Austria, Automation, Catchment areas, Computer programs, Data collections, Data storage and retrieval, Experimental basins.

Hydrological data acquisition is usually based on the measurement of discrete values at constant time intervals. Time-constant data acquisition usutime intervals. Time-constant data acquisition usu-ally allows only inexact data sampling, or sampling with a high volume of storage, depending on the time interval used. The method of time-variable data recording uses only the points of time with relevant information, thus increasing resolution and decreasing storage demands. It has been ap-plied since 1979 both for rainfall and runoff gages in the Pollau experimental basin in East Styria, Austria, and provides a completely automatic way Austria, and provides a completely automatic way of data acquisition by a microcomputer system. It is not only possible to use the continuous time

#### Group 7A-Network Design

series for numerical investigations both in time and space, but this sampling technique also allows the analysis of events and the use of their information analysis of events and the use of their information as inputs for forecasting and other models. The resolution of every hydrological variable can be chosen beforehand. Regional networks can be established and used as sub-information for larger drainage basins. The information stored in a database can be linked and provides large time series with high resolution, but the method of times veries. with high resolution by the method of time-variable data recording. (See also W91-10103) (Author's abstract) W91-10117

FUTURE FOR OPERATIONAL HYDROLO-GY--A WMO PERSPECTIVE. World Meteorological Organization, Geneva

(Switzerland).
For primary bibliographic entry see Field 6E.
W91-10132

PROCEDURES FOR GROUND-WATER INVES-TIGATIONS.

Battelle Pacific Northwest Labs., Richland, WA. Available from the National Technical Information Service, Springfield, VA. 22161, as DE90-000639. Price codes: A13 in paper copy, A01 in microfiche. Report No. PNL-6894, September 1989. 195p, 39 fig. 3 tab, 54 ref. DOe Contract DE-AC06-76RLO

Descriptors: \*Aquifer testing, \*Data acquisition, \*Data interpretation, \*Groundwater data, \*Groundwater resources, \*Handbooks, \*Monitoring, \*Test wells, Aquifers, Geochemistry, Geophysics, Groundwater level, Hydrologic properties, Monitoring wells, Sediment analysis, Sediment contamination. Wells.

This manual was developed by the Pacific North-west Laboratory (PNL) to document the proce-dures used to carry out and control the technical aspects of groundwater investigations at the PNL.
Groundwater Monitoring Procedures are developed and used in accordance with the PNL Quality Assurance Program. Manual highlights include: ity Assurance Program. Manual highlights include:
groundwater sample chain-of-custody procedure;
analytical data handling and verification procedure;
geochemical monitoring of well development; calibration of conductivity meter and measurement of
field conductivity; calibration of pH meter and
measurement of field pH; water level measurement
procedure; contaminated sediment sampling; geophysical well logging van operating procedure. procedure; contaminated secument sampling; geo-physical well logging van operating procedure; sediment sample analysis/sample control proce-dure; configuration of surface fittings and monitor-ing devices for well development or hydrologic testing; well development before hydrologic testi-ing; and, aquifer slug injection and withdrawal test. (Lantz-PTT) W91-10243

#### APPLICATION OF DATA ANALYSIS TECHNIQUES TO SLUDGE AND SOIL SAMPLING OPERATIONS.

Institut de Recherches Hydrologiques, Nancy (France). F. Colin.

IN: Sampling Problems for the Chemical Analysis of Sludge, Soils and Plants. Elsevier Science Publishing Co., New York. 1986. p 66-78. 4 fig, 4 tab.

Descriptors: \*Data acquisition, \*Data interpreta-tion, \*Sampling, \*Sludge, \*Sludge analysis, \*Soil analysis, Heavy metals, Spatial distribution, Statis-tical analysis, Variability, Waste characteristics

Data analysis techniques for sludge and soil sampling operations are discussed. Studies of sludge sampling operations have indicated that the characteristics of successive elementary samples are often related and that the set of analysis results is often related and that the set of analysis results is therefore nonrandom in structure. A progressive sampling approach is followed for a sludge deposi-tion site: (1) set arbitrary sampling grid; (2) charac-terize small number of samples fully; (3) determine variability of samples and choose lead parameters which have variabilities representative of all sample characteristics; (4) measure leading param-

eters of large number of samples; (5) analyze data for spatial variability, (6) if necessary, additional sampling along axis of greatest variability; (7) statistical analysis of all data; and (8) general concluissue a manysts of an uata; and (s) general concur-sions on spatial distribution of waste constituents. An example of a solid deposit of sludges was studied over a height of 120 cm. The chief charac-teristics of the waste were found to develop in a continuous fashion along the primary axis of sludge discharge. The ratio of extreme values along the axis of discharge was 7 for lead, 5 for zinc, and 1.4 for aluminum. Results also indicated the presence for alumnum. Results also indicated the presence of a deposit zone having high concentrations of zinc (30% of dry matter) and lead (6% of dry matter). Progressive sampling and data analysis of sludge deposits or sludge-amended soils allows for rapid identification of the spatial distribution of waste constituents. (See also W91-10461) (MacKeen-PTT)

#### 7B. Data Acquisition

IDENTIFICATION OF COPPER CONTAMINA-TION IN SEDIMENTS BY A MICROSCALE PARTIAL EXTRACTION TECHNIQUE,

Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5A. W91-09340

MICROLYSIMETER SOIL COLUMNS FOR EVALUATING PESTICIDE THROUGH THE ROOT ZONE.

Wisconsin Univ.-Madison. Dept. of Soil Science. For primary bibliographic entry see Field 5B. W91-09345

ERROR STRUCTURE OF MULTIPARAMETER RADAR AND SURFACE MEASUREMENTS OF RAINFALL, PART I: DIFFERENTIAL REFLEC-

Colorado State Univ., Fort Collins. Dept. of Elec-trical Engineering. For primary bibliographic entry see Field 7C. W91-09382

DETECTION OF ESCHERICHIA COLI AND SHIGELLA SPP. IN WATER BY USING THE POLYMERASE CHAIN REACTION AND GENE PROBES FOR UID.

Louisville Univ., KY. Dept. of Biology. For primary bibliographic entry see Field 5A. W91-09444

CONCEPT OF A HYDROPHYTE FOR WET-LAND IDENTIFICATION.

Fish and Wildlife Service, Newton Corner, MA. For primary bibliographic entry see Field 2H. W91-09453

GIS PROVING GROUNDS FOR WATER RE-SOURCES RESEARCH.

Purdue Univ., Lafayette, IN. Water Resources Research Center.

For primary bibliographic entry see Field 7A. W91-09468

GUIDELINES FOR COLLECTION AND FIELD ANALYSIS OF WATER QUALITY SAMPLES FROM STREAMS IN TEXAS.

Massachusetts Inst. of Tech., Cambridge. Microsystems Technology Labs. F. C. Wells, W. J. Gibbons, and M. E. Dorsey. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-127, 1990. 79p, 12 fig, 7 tab,

Descriptors: \*Instrumentation, \*Measuring instruments, \*Sample preservation, \*Sampling, \*Water quality, Alkalinity, Bacterial analysis, Dissolved oxygen, Hydrogen ion concentration, Specific conductivity, Standards, Temperature.

This manual provides a set of standardized guide-This manual provides a set of standardized guide-lines and quality-control procedures for the collec-tion and preservation of water-quality samples and defines procedures for making field analyses of unstable constituents or properties, including water temperature, specific conductance, pH, alkalinity dissolved oxygen, and bacteria. Descriptions and procedures for several methods of sampling are described for which a variety of samplers may be used. Sample-processing devices such as sample churns and filtration anneatus are discussed along used. Sample-processing uvertees such as sample-churns and filtration apparatus are discussed along with methods of cleaning. Analyses for unstable constituents or properties are by necessity per-formed in the field. (USGS) W91-09481

CHEMICAL STABILITY OF WET-DEPOSITION SAMPLES SUBSAMPLED DAILY FOR

Geological Survey, Denver, CO. Water Resources

T. C. Willoughby, L. J. Schroder, and R. B. See. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4003, 1990. 19p, 14 fig, 8 tab, 9 ref.

Descriptors: \*Chemistry of precipitation, \*Sample preservation, \*Sampling, \*Water analysis, Acid rain, Calcium, Chlorides, Magnesium, Nitrates, Potassium, Precipitation collectors, Sodium, Specific conductivity, Stability analysis, Statistical analysis, Sulfates, Water chemistry.

During 1988, the U.S. Geological Survey examined the chemical changes that occur in wet-deposition samples stored in a collector for one week. Samples from ten storms that resulted in 1.3 mm or Samples from ten storms that resulted in 1.3 min of more of precipitation were collected in a wet-only collector using 13-liter polyethylene buckets. About 25 ml of the sample was removed daily from the bucket and filtered for each subsampling. After the pH and specific conductance for each daily subsample were determined, the remainder of the sample was preserved for ion chromatography and flame atomic absorption spectrometry or flame atomic emission spectrometry. Chloride, nitrate, and sulfate concentrations were determined by ion chromatography. Calcium concentrations were de-termined by flame atomic emission spectrometry, and magnesium, sodium, and potassium concentra-tions were determined by flame atomic absorption spectrometry. The subsamples were chilled at 4 C until all the subsamples for an individual storm were removed. Then all the samples were analyzed. A Kendall's estimator was used to estimate the slope and a non-parametric regression equation was determined for each analyte. A Kendall's tau estimator of rank correlation was used to determine the presence of any statistically significant correlation between the analyte concentration and correlation between the analyte concentration and the time that the sample remained in the collection bucket. Statistically significant correlations were determined for calcium and hydrogen ion, indicat-ing that the sample chemistry is changing with respect to the length of time that the sample re-mained in the collection bucket. (USGS) W91-09496

COMPARISON OF RECORDING CURRENT METERS IN SHALLOW WATERS OF SAN FRANCISCO BAY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.

J. W. Gartner, and R. N. Oltmann.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4018, 1990. 84p, 18 fig, 7 tab, 18 ref.

Descriptors: \*Bays, \*Current meters, \*Data acquisition, \*Estuaries, \*Instrumentation, \*San Francisco Bay, California, Shallow water, Wind-wave

Four recording current meters with different types of speed sensors were field tested to determine their ability and accuracy for collecting velocity data in shallow, tidally affected waters under the influence of wind-generated waves. The speed sen-

#### Data Acquisition—Group 7B

sors tested included a horizontal-axis ducted impel-ler, a vertical-axis Savonius rotor, an inclinometer and an electromagnetic system. All meters were positioned approximately 1.2 m above the bottom of the bay in an area where the water depth ranged from 2.0 to 5.1 m, and windspeeds generally were 5 to 10 m/sec. Comparison of recorded current-speed data indicated that the vertical-axis rotor and inclinometer meters are sensitive to orbital wave motion induced by wind and that the horizonal-axis ducted impeller and electromagnetic meters are not. The degree to which the recorded data for the vertical-axis rotor and inclinometer meters are affected by the orbital motion is dependent on the magnitude of the wind and the depth of water magnitude of the wind and the uspin of waste above the meter. The data comparison also indicated that, during periods of light winds when wave motion was slight, current-speed readings determined by horizonal-axis ducted impeller and vertically and the substitution of the wind was substituted in the work of the work mined by horizonal-axis ducted impeller and vertical-axis rotor meters were in close agreement, as were readings determined by electromagnetic and inclinometer meters. However, the latter two meters recorded higher speed values during maximum-flood and maximum-ebb periods than did the horizontal-axis ducted impeller and vertical-axis rotor meters. Multiple deployments of horizontal-axis ducted impeller and vertical-axis rotor meters. were made; comparison of records collected using the same type of meter indicated variations up to 20%. (USGS) W91-09526

EXTERNAL QUALITY-ASSURANCE RESULTS FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/NATIONAL TRENDS NETWORK DURING 1988.

Geological Survey, Denver, CO. Water Resources

Div. R. B. See, T. C. Willoughby, and J. D. Gordon. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4030, 1990. 26p, 9 fig, 9 tab, 11 ref.

Descriptors: \*Acid rain, \*Chemical analysis, \*Quality assurance, \*Sample preservation, \*Water analysis, Chemistry of precipitation, Laboratories, Precipitation, Rainfall.

The U.S. Geological Survey used four programs in 1988 to provide external quality assurance for the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). Onsite pH and specific-conductance determinations were evaluated in the intersite-comparison program. The effects of routine sample handling on analyte detereffects of routine sample nanding on analyte deter-minations and an estimated precision of analyte values and concentrations determined in the NADP/NTN samples were evaluated in the blind-audit program. Differences between analytical results and an estimate of the analytical precision of three participating laboratories were determined by the interlaboratory-comparison program. An estimate of overall sampling precision was determined by the collocated sampler program. Results mined by the collocated sampler program. Results of the intersite-comparison program indicate that 88 to 94% of the onsite pH determinations and 95 and 96% of the onsite specific-conductance determinations were within program goals during 1988. The effect of routine sample handling, processing, and shipping as determined in the blind-audit program, indicated significant positive bias of calcium, magnesium, sodium, and chloride ions and a negative bias for hydrogen ion and specific conductance for blind-audit samples handled according to program protocols. A Kruskal-Wallis test indicated that significant (alpha = 0.01) differences did not occur among the analytical results from the three laboratories participating in the interlaboratory program. An insufficient amount of data was gathered during 1988 to estimate the precision of data collected using collocated samples. (USGS)

APPLICATIONS OF DOWN-WELL/DOWN-WELL AND DOWN-WELL/SURFACE RESISTIVITY TECHNIQUES TO EVALUATE GROUND WATER FLOW IN FRACTURES. Connecticut Univ., Storrs. Dept. of Geology and Geophysics.

For primary bibliographic entry see Field 2F.

W91-09569

GEOPHYSICAL BOREHOLE LOGGING, AP-PLICATIONS (AND LIMITATIONS) TO GROUNDWATER INVESTIGATIONS IN SHALLOW AND SMALL DIAMETER WELLS.

C. B. Clemmens.
IN: Ground Water Issues and Solutions in the Notional Water Issues and Southflow in the Potomac River Basin/Chesapeake Bay Region. National Water Well Association, Dublin, Ohio. 1989. p 47-68. 12 fig, 1 tab, 6 ref.

Descriptors: \*Borehole geophysics, \*Geohydrology, \*Geophysical methods, \*Well logs, Electrical studies, Geothermal studies, Groundwater chemistry, Lithology, Radioactive well logging, Test wells, Water analysis, Well data.

Geophysical borehole logs can provide both a quick field analysis of wells and data for detailed analysis at a future date. These data can include lithologic information on strata penetrated, relative lithologic information on strata penetrated, relative porosity of the strata, fractures, groundwater flow and groundwater chemistry. Clays and shales are readily recognizable on the natural gamma log, due to the abundance of K40 and other radioisotopes in clay minerals. Sandstones, limestones, and coals can usually be differentiated using the natural gamma log and the gamma-gamma density log. Porosity can be observed on the neutron and density logs while small fractures are best detected on the short-spaced focussed density (high resolution) log. The temperature log offers the best indication of groundwater flow, based on interruptions in the geothermal gradient. Some indication of groundwater chemistry can be obtained from the fluid water chemistry can be obtained from the fluid conductivity log. Classic electric logs, including the several variations of resistivity and spontaneous potential, are generally less diagnostic in the shallow, fresh water environment than are nuclear logs. While in many circumstances they do represent an acceptable alternative to core drilling, geo-physical logs are not substitutes for packer testing and laboratory analysis. They can be used as sup-plements to these tests, to focus testing and sam-pling on zones most likely to yield the desired information. (See also W91-09628) (Author's abstract) W91-09632

DIATOM FRUSTULES AS NATURAL TRAC-ERS TO DETERMINE THE ORIGIN OF SUS-PENDED MATTER IN THE WESER ESTUARY. Bremen Univ. (Germany, F.R.). For primary bibliographic entry see Field 2L. W91-09662

RELEASE OF 2,4-DICHLOROBENZOIC ACID FROM SILICONE TUBING.

Aarhus Univ. (Denmark). Inst. of Geology. P. Nornberg, and E. V. Sorensen. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 9, p 863-866, 1990. 4 fig, 1 tab, 7 ref.

Descriptors: \*Chlorinated aromatic compounds, \*Lysimeters, \*Sample preservation, \*Sampling, \*Silicones, \*Water analysis, Denmark, Laboratory methods, Soil analysis.

In a soil project in Denmark where water was collected in percolation lysimeters, a high concentration of 2,4-dichlorobenzoic acid was detected which significantly interfered with soil analysis. The compound was suspected to be a contaminant from either the lysimeter material itself or from the farm areas around the experimental plot. It was determined that 2,4-dichlorobenzoic acid is released from the lysimeter silicone tubing when placed in contact with natural soil and rainwater. The compound is probably a derivative of the placed in contact with natural soil and rainwater.

The compound is probably a derivative of the bis(2,4-dichlorobenzoyl)peroxide used in the production of silicone rubber. Caution should be used in any industry where silicone tubing is utilized. (D'Agostino-PTT) W91-09663

TRACE ORGANICS DETERMINATION IN DRINKING AND SURFACE WATERS.
Venice Univ. (Italy). Dept. of Environmental Sci-

For primary bibliographic entry see Field 5A. W91-09669

ABSENCE OF CAESIUM-137 FROM RECENT SEDIMENTS IN EASTERN AUSTRALIA--INDI-CATIONS OF CATCHMENT PROCESSES, Sydney Univ. (Australia). Dept. of Geography. For primary bibliographic entry see Field 2J. W91-09692

INSTRUMENT SYSTEM FOR PROFILING SUSPENDED SEDIMENT, FLUID, AND FLOW CONDITIONS IN SHALLOW MARINE ENVI-RONMENTS.

Washington Univ., Seattle. School of Oceanogra-

phy.

R. W. Sternberg, G. C. Kineke, and R. Johnson.
Continental Shelf Research CSHRDZ, Vol. 11,
No. 2, p 109-122, February 1991. 8 fig, 1 tab, 6 ref.
U.S. National Science Foundation Grant OCE-8813399

Descriptors: \*Flow profiles, \*Instrumentation, \*Samplers, \*Sediment sampler, \*Sediment transport, \*Suspended sediments, \*Water sampling, Brazil, Flow characterization, Fluid flow, Marine sediments, Sediment sampling, Sensors, Shallow water, Water column.

A new instrument system (sediment profiler) has been developed which is designed for making suspended sediment transport observations in shallow marine waters. The instrument system is capable of obtaining simultaneous profiles through the water obtaining simultaneous profiles through the water column of suspended sediment concentration (Cz), fluid properties (conductivity, temperature, depth) and along-flow and cros-flow conditions (Uz, Vz), and of collecting water/suspended sediment samples at selected depths. Additionally, it can be used in a calibration mode to intercompare multiple optical backscatter sensors (up to eight sensors). The sediment profiler is a relatively small aluminum tripod (91 cm high) that can be lowered through the water column in strong flows (approximately 2 m/s), measure suspended sediment concentrations between 5 mg/L and approximately 10 g/L, and can be lowered directly to the seabed 10 g/L, and can be lowered directly to the seabed (sensor elevations approximately 20 cm). It con-(sensor elevations approximately 20 cm). It con-tains internal battery power and on-board digital logging capabilities and has no electrical connec-tion with the vessel during operation. Since July 1989 the sediment profiler has been used extensive-1989 the sediment profiler has been used extensively on a study of the Amazon shelf transport system (AmasSeds). Numerous profiles have been collected from hydrographic surveys off the northeast coast of Brazil to investigate spatial distributions of suspended sediment and to monitor net particle flux over 25 h anchor stations. The instrument system is rugged and reliable and has improved the ability to document the relationships between fluid system is rugged and reliable and has improved the ability to document the relationships between fluid properties, flow conditions, and suspended sedi-ment characteristics in a complex shelf environ-ment. (Author's abstract) W91-09698

INVERSE METHOD FOR ESTIMATING SOIL CORE WATER CHARACTERISTICS.

Institut National de la Recherche Agronomique de K. Zayani, J. Tarhouni, G. Vachaud, and M.

Journal of Hydrology JHYDA7, Vol. 122, p 1-13, January 1991. 3 fig, 3 tab, 19 ref.

Descriptors: \*Hydrologic models, \*Mathematical studies, \*Soil water, Analytical methods, Boundary conditions, Drainage, Hydrologic budget, Pre-

diction, Tensiometers.

The experimental determination of soil water characteristics by classical methods (such as internal drainage or water balance) is tedious and time consuming. Combination of the flux concentration consuming. Commination of the flux concentration approach and the double integration method leads to an optimal quasi-analytical solution of water absorption by soil through an impeding surface layer. This leads to a straightforward procedure for estimating soil water properties, in laboratory

#### Group 7B—Data Acquisition

conditions, without using tensiometers of gamma-ray equipment. Soil water characteristics of previ-ously known power forms for water contents below the bubbling-pressure value were studied. The resulting solution was used to estimate soil water properties from the position of the wetting front, cumulative inflow data and knowledge of the hydraulic resistance of the crust. The accuracy of the method was assessed using literature data The basic outcome of this analysis was the noteworthy flexibility of the optimal solution obtained by combining the flux combination and the double integration methods. The solution may be used, with acceptable accuracy, for either prediction or estimation of soil water characteristics. Further investigation of the solution leads to an improvement of an earlier approximation of the flux con-centration relation when absorption in linear soil under flux boundary conditions is of concern. (Agostine-PTT) W91-09731

HYDROGRAPH SEPARATION: A COMPARISON OF GEOCHEMICAL AND ISOTOPE TRACERS.

Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
For primary bibliographic entry see Field 2E.
W91-09745

SPECTRAL RESPONSE OF SUSPENDED SEDIMENTS IN WATER UNDER CONTROLLED CONDITIONS.
Jawaharial Nehru Univ., New Delhi (India).

Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences. V. K. Choubey, and V. Subramanian. Journal of Hydrology JHYDA7, Vol. 122, p 301-303, January 1991. 5 fig, 2 tab, 7 ref.

Descriptors: \*Radiometry, \*Remote sensing, \*Satellite technology, \*Spectral analysis, \*Suspended sediments, \*Turbidity, India, Minerals, Physical properties, Watersheds, Wavelengths.

A laboratory experiment using a spectral radiome-ter has determined the spectral characteristics of suspended sediment in water under controlled conditions in four wavelength bands (0.45-0.9 micrometer) as a function of type and concentration of sediment. The pattern of reflectance of natural black and brown sediments from a small catchment in central India has been determined, as has the feasible limit of concentration of sediments that can be measured in the four wavelength bands used by the Indian Remote Sensing Satellite LISS-1. The results indicate that the spectral characteristics of black and brown sediments depend largely on the mineral composition, color, and size of the sedi-ments rather than on the total amount of suspended sediments in the water. It was also found that shorter wavelengths are more useful than longer wavelengths for turbidity mapping. Wavelength bands covering the visible range of the spectrum available in the Indian Remote Sensing Satellite avalable in the initial Reinite Sensing Satellite sensors need to be considered if suspended sediments are to be estimated. (Agostine-PTT) W91-09748

RETRIEVAL OF MONTHLY RAINFALL INDI-CES FROM MICROWAVE RADIOMETRIC MEASUREMENTS USING PROBABILITY DIS-TRIBUTION FUNCTIONS.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2B. W91-09800

CROUND-RASED MEASUREMENTS RAINDROP FALLSPEEDS.

Auckland Univ. (New Zealand). Dept. of Physics. For primary bibliographic entry see Field 2B. W91-09801

DETERMINATION OF PRECIPITATION PRO-FILES FROM AIRBORNE PASSIVE MICRO-WAVE RADIOMETRIC MEASUREMENTS. National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.

For primary bibliographic entry see Field 2B. W91-09802

COMPLETE POLARIMETRIC AND DOPPLER MEASUREMENTS WITH A SINGLE RECEIV-ER RADAR.

National Severe Storms Lab., Norman, OK For primary bibliographic entry see Field 2B. W91-09803

USE OF ROTATING PINHOLES AND RETI-CLES FOR CALIBRATION OF CLOUD DROP-LET INSTRUMENTATION.

Sverdrup Technology, Inc., Cleveland, OH. E. A. Hovenac, and E. D. Hirleman. Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 8, No. 1, p 166-171, February 1991. 8 fig, 7 ref.

Descriptors: \*Calibrations, \*Clouds, \*Ice, \*Instrumentation, \*Remote sensing, Fluid drops, Ice formation, Optical properties, Probes, Spectrometers.

Information from the study of icing clouds enables researchers to model ice formation on aircraft more accurately, design de-icing systems, and improve the safety of winter time flights. Measurement of droplet size distributions in icing clouds may be performed with the Forward Scattering Spectrometer Probe (FSSP) and the Optical Array Probe (OAP) Calibration devices for these instru-ments have been developed. The device used with the FSSP is a rotating pinhole calibrator. It utilizes light diffracted by a pinhole of a known diameter to simulate scattered light from a water droplet. This device can be used to calibrate the FSSP, measure the FSSP's optical collection angles and for instrument alignment and troubleshooting. The device used with the OAP is a rotating reticle calibrator. Chrome disks of a known diameter on the reticle are used for calibration of the OAP and for determining the OAP's response to out-of-focus particles in the probe volume. (Fish-PTT) W91-09804

MICHIGAN GROUNDWATER SURVEY: A CO-OPERATIVE VENTURE OF LOCAL GOVERN-

Western Michigan Univ., Kalamazoo. Science for Citizens Center. For primary bibliographic entry see Field 6E. W91-09894

POTENTIAL OF SOME CAROTENOIDS IN TWO RECENT SEDIMENTS OF KIEL BIGHT AS BIOGENIC INDICATORS OF PHYTODE-

Bremen Univ. (Germany, F.R.). Fachbereich 2 -Studiengang Biologie.
For primary bibliographic entry see Field 2L.

UNIQUE SOIL-CARBONATE LIBERATION TECHNIQUE FOR USE WITH CARBON-14-LA-BELED CARBONATE.

Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment. M. I. Sheppard, and W. J. Schwartz.

Soil Science Society of America Journal SSSJD4, Vol. 55, No. 1, p 279-282, January/February 1991. 2 fig, 2 tab, 21 ref.

Descriptors: \*Analytical methods, \*Carbon radioisotopes, \*Carbonates, \*Chemical analysis, \*Groundwater pollution, \*Path of pollutants, \*Soil analysis, Carbon dioxide, Geohydrology, Labora-tory equipment, Pollutant identification, Radioac-tive dating, Solute transport.

A fast, inexpensive, and efficient method was developed to liberate 14-C-labeled CO3 from soil, and trap the evolved 14-C-CO2 in vials ready for liquid scintillation counting. The apparatus is fabricated with microanalytical materials that minimize the contact surfaces and total internal gas volume. Another advantage is that the trapped CO2 is directed immediately into the counting vial, ready for analysis. Recoveries of standard additions to

soil were always >97% and usually 99.9%. Comparison of this method with a similar direct CO2parison of this method, now being used to radiocarbon date hydrological and geological samples, proves this method gives results similar to the traditional methods. Recoveries from non-carbonated and carintentions. Recoverse from non-carbonated and car-bonated (6% CO3) soil cores, spiked to simulate entry of contaminated groundwater, support the usefulness of this method for 14-C soil transport studies. (Author's abstract) W91-09974

DRILLING METHOD FOR COLLECTION OF UNDISTURBED SOIL MONOLITHS.

Sveriges Lantbruksuniversitet, Uppsala. Div. of Agricultural Hydrotechnics. For primary bibliographic entry see Field 2G. W91-09975

SIMULATION MODELING SYSTEM FOR AQUATIC BODIES

Akademiya Nauk SSSR, Moscow. Vychislitelnyi

Tsentr.
A. A. Voinov, and A. A. Akhremenkov.
Ecological Modelling ECMODT, Vol. 52, No. 3/
4, p 181-205, December 1990. 11 fig, 3 tab, 35 ref.

Descriptors: \*Aquatic environment, \*Computer models, \*Hydrologic models, \*Mathematical models, \*Model studies, Computer programs, Data interpretation, Ecosystems, Simulation analysis.

A user-friendly interactive modeling system (Simulation Modeling System for Aquatic Bodies (SIMSAB)), designed as a personal computer inter-face, was formulated in terms of a special flow language, which is then automatically translated to produce portable Fortran programs that can be run on any computer. Additional blocks and processes can be put into the system by a user who knows Fortran. The system is intended for the construc-tion of compartmental models and includes a spetion of compartmental models and includes a spe-cial hydrodynamic block to calculate wind-in-duced currents and to account for the material exchange between departments. SIMSAB brings together ecological and mathematical studies in an interactive mode to obtain new insights into princi-ples of accounterm operations and compared accounter. ples of ecosystem operation and more adequate representations of ecosystem dynamics. (Author's abstract) W91-10008

SATELLITE MICROWAVE MEASUREMENTS OF ATMOSPHERIC WATER VAPOUR AND MARINE WIND SPEED: CASE STUDY APPLI-CATION.

Cape Town Univ. (South Africa). Dept. of Oceanography. For primary bibliographic entry see Field 2B. W91-10012

INTEGRATION OF REAL-TIME FORECAST-ING AND ENGINEERING WORKSTATIONS. International Hydrological Services, Sacramento,

D. C. Curtis, D. E. Colton, and D. C. Leader. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p 15-19. 1 fig.

Descriptors: \*Automation, \*Computers, \*Data acquisition, \*Data interpretation, \*Data processing, \*Forecasting, \*Network design, \*Streamflow forecasting, \*Telemetry, Computer models, Computer programs, Data collections, Data transmission, Databases, Microcomputers, Model studies, Networks Private forecasting. works, River forecasting.

Microcomputer-based, real-time river forecasting systems are being implemented with increasing frequency throughout the world. Powerful microprocessors using multi-user, multi-tasking operat-ing systems have enabled personal computers to perform forecasting operations previously reserved for minicomputer or mainframe computer environments. As an example, the city of Los Angeles has developed a microcomputer-based river forecasting system using a personal computer. The system currently employs a Compaq 286 Deskpro person-

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al computer to collect data from 488 sensors, fore-cast 32 headwaters at 12 minute intervals, and route flows through 21 reservoirs. In addition, the computer is handling 2 leased telephone lines to pass information onto other computers, 2 dial-up telephone lines to accommodate outside users, one printer, one external alarm, and one back up car-tridge disk system. Local and wide area networks are available to extend the power of individual workstations. With a networked system of micro-computers or workstations, many departments can computers or workstations, many departments can be linked together with access to the real-time and historical data base. Individual stations could be nistorical data base. Individual stations could be located in Engineering, planning, emergency management, and flood control offices. Application programs germane to each office can be executed on their resident network node with real-time access to the central hydrometeorological data base. (See also W91-10018) (Author's abstract) W91-10053

DEM DATA USED TO DEVELOP RUNOFF IN AREAS OF DEPRESSIONAL STORAGE. Bureau of Reclamation, Billings, MT.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p J1-J7. 2 fig, 21

Descriptors: \*Computer models, \*Data interpreta-tion, \*Depression storage, \*Digital elevation models, \*Digital map data, \*James River, \*Model studies, \*Rainfall-runoff relationships, \*Runoff, Aerial photography, Computer programs, Com-puters, Data acquisition, Hydrologic data, James-town Dam, North Dakota, Potholes, Storage ca-pacity Storms. pacity, Storms.

The Bureau of Reclamation and the National Mapping Division of the U.S. Geological Survey, have collaborated on a project to assess the runoff potential of the James River above Jamestown Dam, North Dakota, following a large magnitude storm. The James River is characterized by low relief and The James River is characterized by low relief and large amounts of depressional storage. The manual determination of hydrologic parameters proved to be inadequate and led to the development of digital elevation models (DEM) for representative test sites in the study area. The DEM's, along with the necessary computer software to analyze the DEM's, led to a more accurate determination of DEM's, led to a more accurate determination of the drainage area into a pothole, the linkage be-tween potholes, and the storage capacity of pot-holes. Various rainfall-runoff models were used to determine the runoff characteristics of the test determine the runoff characteristics of the test sites. Results of the test site analysis showed the pothole storage can have a large effect on both the magnitude and shape of runoff hydrographs. (See also W91-10018) (Author's abstract) W91-10055

REVISED PROCEDURAL GUIDE FOR DESIGNATION SURVEYS OF OCEAN DREDGED MATERIAL DISPOSAL SITES.

LGL Ecological Research Associates, Inc., Bryan,

For primary bibliographic entry see Field 5G. W91-10068

USEPA METHOD STUDY 35, SW METHOD 3005, ACID DIGESTION OF WATERS FOR TOTAL RECOVERABLE OR DISSOLVED METALS FOR ANALYSES BY FLAME ATOMIC ABSORPTION SPECTROSCOPY. Bionetics Corp., Cincinnati, OH. K. W. Edgell.

K. W. Edgell. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-190573. Price codes: A13 in paper copy, A01 in microfiche. Report No. EPA/600/1-89/015, April 1989. 270p, 2 fig. 12 tab, 8 ref, 6 append. EPA Contract 68-03-3254.

Descriptors: \*Analytical methods, \*Atomic absorption spectrophotometry, "Chemical analysis, "Laboratory methods, "Metals, "Pollutant identifi-cation, "Water analysis, Data acquisition, Hydro-chloric acid, Nitric acid, Spectrophotometry.

An interlaboratory collaborative study was con-ducted to determine the precision and mean recov-

ery of Solid Waste (SW) Method 3005 for total ery of Solid Waste (SW) Method 3005 for total recoverable metals by flame atomic absorption on 21 elements in groundwater. SW Method 3005 is entitled 'Digestion of Total Recoverable or Dissolved Metals for Analysis by Flame Atomic Absorption Spectroscopy or Inductively Coupled PLasma Spectroscopy and includes instructions for quality control, sample preparation and analysis of samples by AA-Flame. The study design was based upon Youden's nonreplicate plan for collaborative tests of analytical methods. Sech weather based upon Youden's nonreplicate plan for col-laborative tests of analytical methods. Each water type was spiked with 6 concentrations (as 3 Youden pairs) of the 21 test elements and was digested using a nitric/hydrochloric acid proce-dure and analyzed by flame atomic absorption spectroscopy. Test data from 3 spiked groundwatr sources were compared against reagent water as control. The resulting data were analyzed using EPA's computer programs entitled 'Interlabora tory Method Validation Study' (IMVS). This study produced, for each element, measures of precision and mean recovery for the acid digestion/flame atomic absorption spectroscopy and compared the performance of the method between water type and reagent water. (Author's abstract) W91-10081

SATELLITE REMOTE SENSING FOR AGRI-CULTURAL PROJECTS.

CULTURAL PROJECTS.
International Bank for Reconstruction and Development, Washington, DC.
Papers presented at a seminar held 30-31 March 1989. World Bank Technical Paper No. 128.
World Bank Publications, Washington, DC. 1990.
227p. Edited by J. P. Gastellu-Etchegorry.

Descriptors: \*Agricultural engineering, \*Conferences, \*Data acquisition, \*Mapping, \*Remote sensing, \*Resources management, \*Satellite technology, \*Symposium, Africa, Agricultural practices, Crop production, Developing countries, Geohydrology, Groundwater data, Land management, Land use, Natural resources, Surveys.

At the World Bank seminar on satellite remote sensing for agricultural projects 18 papers illustrated a wide variety of successful applications of the technology. Many of the papers also show entirely new applications not possible with conventional approaches. Illustrations of improvements in accuracy and cost-effectiveness were given for land use mapping in many parts of the world, for satellite hydrogeology, and for improved estimates of crop production statistics in the Sudan. In Burkina-Faso, satellite remote sensing data improved water bore-hole prospecting and gave an increase in average borehole yield from 1.4 cu m/h to 4 cu m/h. Innovative applications of satellite remote sensir included natural resources in the Sahel, famin monitoring and locust infestation assessment in Africa, and the implications of the results of satellite remote sensing for policymaking. The next stages of the application of satellite remote sensing for developing countries will have to concentrate on needs. (See W91-10085 thru W91-10102) (Fish-PTT) W91-10084

REMOTE SENSING ACTIVITIES IN THE WORLD BANK: A REVIEW OF EXPERIENCES AND CURRENT TECHNICAL CAPABILITIES. International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div. G. Morgan.

In: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 1-9, 2 append.

Descriptors: \*Agricultural engineering, \*Data acquisition, \*Geographic information systems, \*Mapping, \*Natural resources, \*Remote sensing, \*Satellite technology, Environmental data, Hydrologic data, Information systems, Landsat images.

To varying degrees the International Bank for Reconstruction and Development in Washington, DC, has been involved with satellite remote sens-ing technology for 15 years. Since 1974 the Bank

has used remote sensing technology in a wide range of applications, including: agriculture and rural development, preparation of satellite image base maps, rangeland assessments, deforestation studies, soil surveys, land-use inventories, groundstudies, soil surveys, land-use inventories, ground-water hydrology studies, regional planning, project feasibility analysis, and project supervision. Since the Bank's reorganization in 1987, the func-tional responsibility for remote sensing activities has been formally established within the Environ-mental Operations and Strategy Division (ENVOS), which focuses on cost-effective tech-niques and methodologies for natural resource sur-veys, environmental baseline studies, and resource inventories. ENVOS has established technical spe-cialists in the fields of natural resource survey and inventory design, geographic information systems ciatists in the fields of natural resource survey and inventory design, geographic information systems technology, remote sensing, digital image processing, resource assessments, and regional land-use planning. Many remote sensing applications have not met expectations because the mapping activities were poorly designed or the technology was used for an inappropriate purpose. Traditionally, one of the greatest constraints to the widespread use of imagery for project identification prepara-tion, and supervision, has been the lack of funding for ad hoc purchases of imagery. With the intro-duction of SPOT imagery there will be a renewed interest in satellite remote sensing, because of the higher resolution imagery, coupled with rapidly decreasing requirements for capital investment in digital image processing. (See also W91-10084) (Fish-PTT) W91-10085

SATELLITE REMOTE SENSING.

Software Science Ltd., Farnborough (England). R. Harris

In: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 11-28, 3 fig, 5 tab, 10 ref, append.

Descriptors: \*Data acquisition, \*Remote sensing, \*Satellite technology, Data collections, Land use, Landsat images, Mapping, Radar.

Satellite remote sensing is now in a phase of transi-tion; while the potential of the technology has been clearly demonstrated, there is still some progress to be made in converting the potential into practical reality. Four satellite remote sensing systems are reviewed: NOAA-AVHRR (National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer), Landsat, SPOT (Satellite Probatoire d'Observation de la Terre), and radar. The economic benefits that users seek are lower direct costs, shorter time scales, higher productivi-ty, and application to future activities. Costs can be ty, and application to future activities. Costs can be divided into direct costs (labor and data), overheads, equipment, and margin (direct profit or some other measure of tangible economic benefit). The overall impact of satellite remote sensing will depend upon the proportion of the value chain occupied by the use of satellite data. The NOAA-VIAPP is a five-horsel sense, best suited to AVHRR is a five-channel sensor best suited to applications that examine relatively large areas. applications that examine relatively large areas. Landsat satellites uses a thematic mapper (TM) used widely for geology, forestry, agriculture, and hydrology land applications. The French SPOT carries a high resolution visible sensor with two modes, and is designed for mapping applications. The emphasis in imaging radar from space has been on synthetic aperture radar (SAR), which operates at microwave wavelengths and can see through clouds, making it possible to collect data on the land and ocean surfaces in all weather conditions. The next decade will see the launch of several new satellites, such as the European Space Agency's ESA-1, culminating in the space station era. (See also W91-10084) (Fish-PTT) W91-10086

LAND USE MAPPING IN THE PHILIPPINES USING SPOT SATELLITE IMAGERY.

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div. B. W. Luscombe.

IN: Satellite Remote Sensing for Agricultural

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Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 29-41, 2 fig, 2 append.

Descriptors: \*Agricultural engineering, \*Data acquisition, \*Land use, \*Mapping, \*Philippines, \*Remote sensing, \*Satellite technology, Cloud cover, Data collections, Information transfer, Land management, Natural resources, Tropical regions, Vegetation.

An important and evolving application of remote sensing technology is the identification and mapping of natural resources for sustainable land use development. SPOT sensitivity in the sensitivity is the sensitivity in the sensitivity is the sensitivity in the sensitivity in the sensitivity is the sensitivity in the sensitivity in the sensitivity is the sensitivity in the sensitivity in the sensitivity is the sensitivity in the sensitivity in the sensitivity is the sensitivity in the sensitivity in the sensitivity is the ping of natural resources for sustainable land use development. SPOT satellite imagery was used to develop national, regional, and provincial statistics on land use and natural resources and to prepare land use classification and satellite image maps for an entire country (the Philippines). The SPOT land cover study of the Philippines demonstrated that current information about the natural resources and land use patterns of a country can be obtained quickly and inexpensively. This study, which produced the land use statistics, as well as complete mapping for the country at a scale of which produced the land use statistics, as well as complete mapping for the country at a scale of 1:250,000, was completed within one year, from April 1987 to April 1988, and cost approximately \$1.7 million (US). The study also demonstrated some of the problems associated with such an activity. It is often difficult to obtain complete satellite image coverage of acceptable quality for a large area, especially in tropical regions because of excessive cloud cover. Also, the technology still has major limitations concerning its ability to disexcessive cloud cover. Also, the technology still has major limitations concerning its ability to dis-criminate among certain types of vegetation cover. In some cases, such discrimination is vital for effec-tive land use planning or for developing commer-cial forest policies. Last, transferring the technolo-gy and the information to a country requires that an appropriate institution and infrastructure be developed to make use of the data and to be able to apply the information technology effectively in sustainable resource development. (See also W91-10084) (Fish-PTT)

## MAPPING FROM SPACE. DIGIM, Inc., Montreal (Quebec).

O. Rochon. IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 43-57, 4 fig, 5 tab, 19 ref.

Descriptors: \*Mapping, \*Remote sensing, \*Satellite technology, \*Topographic mapping, Baseline studies, Data acquisition, Data collections, Geographic information systems, Land management, graphic information systems Natural resources, Precision.

There is an acute need for basic geographic infor-mation to manage land and natural resources better and to understand the impact of human activities on the environment. Base maps constitute a major contribution to the establishment of this basic information. The potential and limitations of using satellite imagery to produce base maps has been examined from recent experiences in various countries and throughout the world. For scales smaller than 1:250,000, the major need is for map revision; for scales between 1:25,000 and 1:150,000, approxifor scales between 1:25,000 and 1:150,000, approximately 50% of the earth remains to be mapped. The only civilian space airborne scanner capable of producing acceptable topographic maps is SPOT, the French satellite first launched in 1986. Two different processes are involved in the creation of a topographic map: planimetric compilation (identification of the type of land cover and features) and altimetric compilation (localization in space of the ground cover). SPOT provides accurate data for the production or revision of small to medium-scale topographical maps, and such activities can be done at a lower cost and in a shorter time than be done at lower cost and in a shorter time than with conventional techniques. These advantages must be balanced against some limitations in preci-sion. There is no hope of creating NATO-level 0 son. There is no hope of creating NATO-level or maps at medium scale or of meeting the planimet-ric requirements for the identification of man-made features. The CARTOSPOT system is a good ex-ample of a high-performance automated system which allows a drastic reduction in control points, compared with conventional systems, and faster

production cycle. Nevertheless, the planimetric in-terpretation requires more control and many point-features are missing. The development of very fast algorithms and new systems based on high-per-formance computers will soon result in systems with the capability of producing the altimetric data for a single map sheet in a few hours, with a precision near the theoretical limit of the input data. (See also W91-10084) (Fish-PTT) W91-10088

#### INVENTORY OF SMALL AND MEDIUM-SIZE IRRIGATION SCHEMES IN ALGERIA USING SPOT NUMERICAL DATA.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 59-66, 2 fig, 1 tab.

Descriptors: \*Algeria, \*Data acquisition, \*Irrigation programs, \*Mapping, \*Remote sensing, \*Satellite technology, Data collections, Data process-

The Algerian Ministry of Hydraulics, Environneed, adjertan ministry of rhydraulics, Environ-ment, and Forestry plans to prepare an inventory of small and medium-size irrigation schemes throughout the north of the country (250,000 sq km). Remote sensing is a well-adapted technique for such an inventory for the following reasons: the available data are recent, exhaustive, and homogeneous; the different wavelengths of the shots allow better identification than aerial black-and-white photographs; numerical data processing allows automatic mapping of the analyzed subjects; and for the same unit area, satellite data are much cheaper than aircraft photographs. The first step in a pilot study was to process the numerical data to produce color composite maps using the three channels of SPOT. Field checks showed that the best period for studying crop areas was April, before cereal harvest. Two different methods were compared to process the numerical data, taking into account the field observations: calculation of vegetation index and supervised classification. The main results of the study are as follows: display of irrigation parcels as small as 1/4 hectares (six grouped pixels corresponding to the minimum reliable identification size); production of color print-outs on a scale of 1:50,000, displaying every scheme in bright red color; and computerized cal-culation of the classified pixels, giving the area of irrigation schemes in the whole scene and within specific divisions (administrative divisions, waterspecific divisions (administrative tuvisions sheds, etc.). Comparison with a study using traditional methods shows that remote sensing is far more accurate and of far shorter duration, but does not show that the study of the study of the shows th not eliminate fieldwork; it allows a general, preliminary, exhaustive view of the schemes which makes a useful stratification of these investigations possible. (See also W91-10084) (Fish-PTT) W91-10089

ROLE OF REMOTE SENSING IN IRRIGA-TION MANAGEMENT: A CASE STUDY ON ALLOCATION OF IRRIGATION WATER. M. Menenti, T. Visser, and J. L. Chambouleyron. In: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 67-81, 3 fig, 3 tab, 12 ref.

Descriptors: \*Agricultural water, \*Irrigation requirements, \*Remote sensing, \*Satellite technology, \*Water allocation, \*Water resources management, Agricultural practices, Cultivated lands, Farming, Irrigation canals, Irrigation water, Landsat images, Mapping, Public policy, Water requirements, Water rights.

Large-scale irrigation systems cannot in practice be separated from their social and economic envibe separated from their social and economic envi-ronment. This issue is relevant to the identification of useful remote-sensing-supported services. Infor-mation can be obtained for effective management of water, land, crops, institutions, and finances. The acceptance of remote sensing devices depends on how accurately the specific irrigation policy applying to each case is taken into account. In the Province of Mendoza, in western Argentina, nine

irrigation districts can be distinguished. Rapid changes are taking place that pose challenging management problems, partly related to the complex hydrology of the region. It was decided to develop a system in which water rights could be acquired permanently by farmers; irrigation water could be allocated on the basis of water rights could be allocated on the basis of water rights versus actually cultivated areas. In principle there are two different ways to apply satellite data to improve implementation of the equitable water allocation policy: update water rights that are temporary and subject to the condition that land be actually cultivated; or map actually cultivated areas and allocate water accordingly, notwithstanding the permanent character of water rights. The initial survey defining water rights has proven The initial survey defining water rights has proven to be inaccurate, and thus not representative of cultivated areas. Two surveys to classify irrigated and nonirrigated areas were made using a Landsat Thematic Mapper (TM) and a Landsat-MSS image. It was found that in general the units at the tail-ends of the main canals tend to have a lower percentage of irrigated land than the ones closer to the head of the main canals, possibly caused by insufficient surface water reaching the tail-ends. If such was the case it would be incorrect to base the future water distribution on the currently irrigated areas, illustrating the fact that before deciding which water allocation policy has to be applied, it is very important to consider all technical and socioeconomic factors involved. (See also W91-10084) (Fish-PTT) W91-10090

### REMOTE SENSING APPLIED TO HYDRO-GEOLOGY THROUGH CASE STUDIES,

T. Pointet

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 83-91, 2 fig, 1 tab.

Descriptors: \*Geohydrology, \*Hydrologic data collections, \*Hydrologic maps, \*Landsat images, \*Remote sensing, \*Satellite technology, Burkina Faso, Developing countries, Geologic mapping, Groundwater potential, Mapping, Morocco, Senegal, Topographic mapping, Water potentials.

In 1988, remote sensing (SPOT and Landsat) was integrated into approximately ten hydrogeological studies abroad. Remote sensing is used at an early stage of study as part of a multidisciplinary approach and gives access to very detailed informa-tion, which ensures added efficiency for the explo-ration or prospecting of difficult zones and it save money on the field reconnaissance of a freshly money on the field reconnaissance of a freshly discovered zone. Three case studies were examined to illustrate the applicability of remote sensing. In 1988 in Senegal, groundwater exploration based on remote sensing and field observation was chosen to save time and cost and to gain informatical. In 1987, transparen ground in the badescreler. tion. In 1987, two space maps with a hydrogeologi-cal theme were drawn up for southern Morocco, for which available data were extremely scarce because of the inaccessibility, the absence of geo-logical maps, and the impossibility of programming airplane coverage. The objective of the third study, carried out in 1988 in Burkina-Faso, was to investigate small-scale irrigation using water contained in the fractured basement rocks in a Sahelian climate. The use of remote sensing to identify linear geological objects and recognize tectonic structures is of prime importance. Integration of results of analysis of structures, the relief shapes, results of analysis of structures, the relief shapes, the drainage pattern, and the study of small-scale fracturing in the field enables preinvestigation. Precise checking methods in the field (geophysical prospecting and radon tracing) lead to the desired efficiency. The rapid classification of the surfaces by ease of infiltration and to cultivation is possible by remote sensing exclusively. These results, added to the first, make it possible to propose sites that are doubly favorable for groundwater development and cropgrowing. (See also W91-10084) (Fish-PTT) W91-10091

SATELLITE HYDROGEOLOGY.

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IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 93-101, 2 fig. 2 tab, 3 ref.

Descriptors: \*Developing countries, \*Geohydrology, \*Groundwater management, \*Groundwater prospecting, \*Remote sensing, \*Satellite technology, Data acquisition, Geologic formations, Geologic mapping, Geological surveys, Groundwater ceharge, Landsat images, Precipitation, Sensors.

The term 'satellite hydrogeology' may be defined as the application of satellite data, imagery, or information to the study of groundwater systems. information to the study of groundwater systems. Much of the emphasis in remote sensing sensors is on resolution and spectral band definition. SPOT has the best resolution (20 m) of the multispectral sensors. However, Landsat's thematic mapper (TM) has a slightly better set of spectral bands (30 m) for vegetation and geology. Its thermal band (120 m) has unique and useful applications for groundwater studies, e.g., detecting seeps and springs. On the other hand, SPOT's panchromatic mode has an unsurpassed resolution (10 m) in the civilian arena, which is most helpful in lineament and fracture trace analysis. NOAA's AVHRR can monitor vegetation over large areas with its 2,600and fracture frace analysis. NOAA's AVIRKE can monitor vegetation over large areas with its 2,600-km swath width. GOES is a geostationary satellite that acts as a weather warning satellite, able to determine precipitation extent and duration, which is necessary for recharge calculations. MOS-1, a ry for recharge calculations. MOS-1, a low-resolution Landsat, is appropriate for regional or mesoscale studies of groundwater or geology. Exploitation for groundwater in undeveloped land involves a series of steps or phases, all of which may be enhanced by remote sensing data: (1) re-search phase (satellite multispectral high-resolu-tion, computer-compatible tape to prepare a draintion, computer-compatible tape to prepare a drain-age map, basin boundaries, a reconnaissance geo-logic map, and a groundwater favorability map). (2) planning phase (a composite picture developed to show the geology, the landforms, and the geo-logic structure, especially the fracture patterns and lineaments); (3) fieldwork phase (carefully recti-fied, enlarged, enhanced satellite image maps on tough plastic film for field use); (4) development phase (use of the field maps as base maps); and (5) environmental monitoring phase (comparison of the before and after images; detection of industrial and agricultural areas; monitoring of precipitation, snowmelt, convective storms, and river basin flows). Satellite hydrogeology represents a means for developing countries to explore, develop, and use their groundwater resources expeditiously, and with minimal exploration costs. (See also W91-10084) (Fish-PTT)

## MONITORING OF NATURAL RENEWABLE RESOURCES AND CROP FORECASTING IN SAHELIAN COUNTRIES.

E. DaTISBAHO. IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 103-114, 10 fig, 1 tab.

Descriptors: \*Remote sensing, \*Resources management, \*Sahel, \*Satellite technology, \*West Africa, Administrative decisions, Agricultural engineering, Cropland, Data acquisition, Data collections, Developing countries, Geographical information systems, Monitoring, Surveys.

project has been undertaken to use methodological tools to improve an operational manner of handling remote sensing and ground survey data for further statistical estimations of annual agricultural resources in the Sahelian countries. The project began in Mali in 1986 and continued through 1989. In 1988, the studies were extended to all the West African Sahelian countries. The to all the West African Sanelian countries. The technical aspects of the project are based on a specifically-designed spatial segmentation approach divided into four major steps: (1) agroeco-logical stratification, (2) agricultural domain identification, (3) landfacet unit identification, and (4) agricultural parcel survey. The two main goals are crop estimation on the one hand, and monitoring of the agricultural campaign and crop prediction on the other. A complete range of procedures

integrated aerial photography, ground survey, and satellite data, either to supervise or to validate the image/processing. All data were input in a geographical information system. NOAA and MEgraphical information system. NOAA and TEOSAT data were used for the initial phase of the project. The estimation of the surfaces of agriculture were obtained by following the project. The estimation of the surfaces of agri-cultural production were obtained by following three main steps. The first step is the extrapolation of ground survey data to the entire landfacet field; the second step is the extrapolation of the landfacet data to the entire agricultural domain; the third step is the compilation of the final result as related to the administrative level taking into account the influence of the agreeological stratification. The to the administrative level taking into account the influence of the agroecological stratification. The present phase of the monitoring project is essentially a methodological phase with a strong request to provide operational procedures in view of a project extension to all Sahelian countries of West Africa. In 1989, this methodological phase will be completed. Present results are groupering. (See completed. Present results are encouraging. (See also W91-10084) (Fish-PTT)

p 115-119.

FAMINE IN AFRICA.
Foreign Agricultural Service, Washington, DC.
B. E. Spiers. D. E. Spiers.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128.

World Bank Publications, Washington, DC. 1990.

Descriptors: \*Africa, \*Agricultural engineering, \*Crop production, \*Drought effects, \*Landsat images, \*Remote sensing, \*Sahel, \*Satellite technology, \*Sudan, Crop yield, Cropland, Data acquisition, Data collections, Grain crops, Sorghum.

Sudan and the Sahelian region of Africa experienced a multiyear drought during the early 1980s. The Sudanese government and officials of the food donor nations were greatly concerned that even though it appeared that the country as a whole might have a grain production surplus, indications were that localized deficits would occur. These areas needed to be identified and relief measures taken. Landsat Multispectral Scanner (MSS) data, coupled with information about cropping patterns, was used to estimated the 1985 sorghum and millet was used to estimated the 1985 sorghum and millet crop areas for the eastern Sudan. The project area covered approximately 51.4 million acres, and cropping practices are typically either part of several large irrigation projects, fixed crop rotations, large dryland parastatal farms, or share-cropping areas. Intensive and extensive ground observations were gathered in the project area, using 12 Landsat images, aerial photographs, and ground data. MSS digital data, using computer compatible tapes (CCTs) and 1:1,000,000 false color transparencies, of the 12 scenes were received within one week of acquisition. Digital classification procedures tend to overestimate vegetative classes. A formal accuracy assessment was not performed during this project due to lack of systematically collected ground truth and time constraints. The official ground truth and time constraints. In collicial millet and grain sorghum area for mechanized-demarcated acreage published in late 1986 was 7.2 million acres, and the satellite-based estimate of December 1985 was 6.6 million acres, a difference of less than 8%. The application of Landsat-MSS satellite data was ideal for this project because of the large faller surper single-crop agriculture and satemic data was ideal for this project because of the large fields, almost single-crop agriculture, and uniform growth stage. The total cost for the remote sensing project was less than \$1.50 (US) per sq mi of the total area surveyed. (See also W91-10084) (Fish-PTT) W91-10094

## REMOTE SENSING AND AGRICULTURAL IN-FORMATION FOR CROP FORECASTING: SUDAN EXPERIENCE.

International Bank for Reconstruction and Development, Washington, DC. Environmental Oper-

opment, Washington, D.C. Environmental Operations and Strategy Div.
H. M. Hassan, and W. Wigton.
IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128.
World Bank Publications, Washington, DC. 1990. p 121-134, 9 tab.

Descriptors: \*Africa, \*Crop production, \*Geographic information systems, \*Mapping, \*Model

studies, \*Remote sensing, \*Satellite technology, \*Sudan, Aerial photography, Agricultural engineering, Crop yield, Data acquisition, Data collections, Developing countries, Landsat images, Sur-

For many years, satellite and aerial photography data have been increasingly incorporated in crop production studies, and it is now certain that their use is directly linked to improved field sampling, improved input to crop-yield models, and in planning agricultural studies associated with crop production. Following the severe drought of 1983-84, steps were taken to improve the system of estimation food cross and engreal bitmers in the Africasteps were taken to improve the system of estimating food crops and general biomass in the African Sudan, including: ground truth surveys; acquisition, processing, analysis, and interpretation of satellite data; an aerial photo survey program based on satellite image interpretation; development of a geographic information system and modeling capability; and incorporation of these data and model into a food grain production estimate program. into a food grain production estimate program. Landsat Thematic Mapper (TM) and Multispectral Scanner (MSS) images obtained during the 1985 growing season were used as base-maps for data stratification. Aerial photography was used for more detailed work. 1986 Landsat-TM data were obtained on both computer-compatible tapes and hard copies. An area sampling frame (ASF) strati-fication exercise was performed. The methodology included primary sampling unit (PSU) construc-tion, PSU measurement, PSU selection, and supplemental aerial photography. It was found that the agreement between the ASF estimates and the management data is remarkably good, with very low coefficient of variation (CV) values (<7%). In general, the larger the area samples, the larger the CV. In areas of traditional agriculture the variability of the results is greatest, because of replanting or misunderstanding of intended planting plans. The total food production estimated by the government is 626,000 t, and the ASF estimate is about 30% less, and probably more accurate, as evidenced by the lower CV (14%). It may be concluded that the difficulties of estimating production in the areas of traditional agriculture are more complex than previously known. (See also W91-10084) (Fish-PTT) W91-10095

## USE OF REMOTE SENSING IN SURVEY, MANAGEMENT, AND ECONOMIC DEVELOPMENT OF TROPICAL RAINFORESTS.

F. Achard, and F. Blasco.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 135-147, 1 tab, 6 ref.

Descriptors: \*Africa, \*Forest management, \*Natural resources, \*Rain forests, \*Remote sensing, \*Satellite technology, \*Tropical regions, Aerial photography, Cameroon, Data acquisition, Data collections, Ivory Coast, Mapping, Resources development, Resources management

Remote sensing techniques have been used to assess the remaining resources and deforested areas of three tropical forests in West Africa (Cameroon and Cote d'Ivoire), and to set up a methodology and principles for the proposal of new working plans. In the Oku Forest in Cameroon, the study goal was to describe precisely the existing series of vegetation and consequently to propose a reserve project. The study analyzed the vegetation, production systems, and photointerpretation. Aerial photographs were used to map the forest regression between 1963 and 1986 at 1:50,000 scale. The SDOT inconsequences are seen to man the actual vagnets. SPOT image was used to map the actual vegeta-tion types at 1:50,000 scale, enlarged to 1:20,000 scale. The significant reduction in time required for vegetation mapping using SPOT imagery is the strongest benefit of this new technology. The study in the Haut-Sassandra Reserve (Cote d'Ivoire) was conducted to determine the actual area of the present forest coverage to establish a rational management plan, requiring a map for three forest stands at 1:50,000 scale. Remote sensing was selected, and the following methodology was used: preliminary steps/preprocessing; photointerpreta-tion of SPOT or TM images; field control; valida-

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tion of the photointerpretation; cartographic synthesis (statistics); and mapping and printing. The results were satisfactory, allowing quite good delineation of forest limits. The flight over forests is an efficient, fast, and cheap tool to obtain actual information on the state of a forest; however, this method does not provide reliable data either on the actual surfaces or on the most recent changes on actual surfaces or on the most recent changes on the limits of vegetation types. The study on the National Park of Marahoue (Cote d'Ivoire) ana-lyzed the fauna, the natural vegetation, and pro-duction systems in adjacent areas. Deforestation affects parts of the park, and the park could be saved by taking into account new management proposals. Remote sensing was used to prepare and to complete field observations, delineating a forest map at 1:50,000 scale. The deforested areas were identified by an automatic method of maximum likelihood classification. (See also W91-10084)

US AID: REMOTE SENSING AND FORESTRY. Agency for International Development, Washington, DC. Office of Science and Technology. J. D. Sullivan.

J. D. Sullivan.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128.

World Bank Publications, Washington, DC. 1990.

Descriptors: \*Forest management, \*Forestry, \*Global warming, \*Remote sensing, \*Resources management, Coastal zone management, Deforestation, Desertification, Ecosystems, Land management, Landsat images, Population dynamics.

A number of current issues argue for the intense utilization of sophisticated remote sensing techniques in the future, including: biological diversity (assessment and inventory over time as well as for monitoring the 'vigor' of entire ecosystems); global climate (measurement of the rate of change of forest and range area); tropical deforestation (building and maintaining real-time information bases); desertification (furnishing cost-effective mechanisms to describe various components of such landscapes for primary assessment and planning intervention strategies); coastal zone (contri-bution to the knowledge base on which to establish wise management of coastal resources on the land and in the sea); and population and environment (measurement of the profound impact of popula-tion on the environment and aid in making land management decisions). These issues are intimately related to each other, as well as to cogent economi-cal and political forces, representing an extremely complex matrix that cannot be resolved by the trial-and-error, case history approach. Contemporary techniques such as remote sensing, geographi-cal information systems, and simulation modeling do a better job of understanding and taking advan-tage of integrated effects to produce desired objectives and to minimize or eliminate unforeseen con-sequences. (See also W91-10084) (Fish-PTT) W91-10097

VEGETATION MONITORING SEASUNAL VEGETATION MONITORING
WITH AVHRR DATA FOR GRASSHOPPER
AND LOCUST CONTROL IN WEST AFRICA.
G. G. Tappan, S. M. Howard, T. R. Loveland, D.
G. Moore, and D. J. Tyler.

G. Moore, and D. J. Tyler.
IN: Satellite Remote Sensing for Agricultural
Projects. World Bank Technical Paper No. 128.
World Bank Publications, Washington, DC. 1990.
p 153-164, 16 ref. USAID, PASA AFR-0510-P-IC7022, and U.S. Geological Survey Contract 14-08-

Descriptors: \*Africa, \*Insect control, \*Mapping, \*Remote sensing, \*Satellite technology, Data acquisition, Data collections, Developing countries, rveys, Vegetation.

With the return to near normal rainfall during the with the return to near normal rainfall during the past several years, environmental conditions favor-able for locusts and grasshoppers have resulted in large populations of these insect pets. Internation-al donors have mounted emergency assistance pro-grams for grasshopper and locust control in Africa. In order to improve surveys and predictions of the

Senegalese grasshopper and the desert locust populations in the Sahelian and Sudanian zones, a pilot project was conducted to develop, test, and evaluproject was conducted to develop, test, and evaluate a near-real-time monitoring procedure using satellite data. The information was presented in the form of vegetation index or 'greenness' maps derived from two-week composites of LAC AVHRR (Advanced Very High Resolution Radiometer) satellite data. These maps show vegetation and moisture conditions which are suitable for support of the pest populations. It was found that Operational use of the maps in 1987 varied from country to country. The maps provided additional information on the intricate patterns of vegetation greention on the intricate patterns of vegetation green-up. In Senegal, the map information was used to send field teams to green areas to implement pest control measures. When used in conjunction with thematic resource information and geographic information systems, the integrated map can serve as a tool to further narrow areas being considered for pest surveys. (See also W91-10084) (Fish-PTT) W91-10098

REMOTE SENSING IN INDONESIA.

REMOTE SENSING IN INDONESIA.

J. P. Gastellu-Etchegorry.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 165-185, 2 fig, 4 tab, 17 ref.

Descriptors: \*Indonesia, \*Remote sensing, \*Resources management, \*Satellite technology, Cloud cover, Computers, Data acquisition, Data collections, Developing countries, Education, Land management, Natural resources.

Indonesia, is trying to improve the monitoring and management of its development activities and numerous natural resources. However, its large area and inaccessibility requires remote sensing technology to fulfill the resource management needs. There are three groups of Indonesian organizations that call upon remote sensing data sources: the remote sensing agencies at a national level, the research institutions and universities, and the government departments and operational agencies. The government sponsors three programs on education and training: a short course on remote sensing, a degree program, and a master's program. The most important constraints concerning local exploitation of satellite data are reviewed: (1) data diffusion: i.e., the necessity of user services in the receiving stations; (2) equipment: essentially equip-ment availability and maintenance; microcomputment availability and maintenance; microcomputer-based systems are particularly efficient for centers that cannot afford the acquisition and maintenance of large computer facilities; (3) cloud cover: in some regions applications that require frequent data acquisition cannot be conducted with visible and near infrared satellite systems; in these cases other systems, such as radar, should be considered; other systems, such as radar, should be considered; (4) atmospheric influence: it is particularly limiting for fully automatic, computer-based mapping; and (5) small size and complexity of local land cover units: consequently, satellite systems that are used should have a comparatively small spatial resolution, such as SPOT. Locally-processed satellite data clearly showed the technical potential of remote sensing as a major and operational data source for many applications in Indonesia. (See also W91-10084) (Fish-PTT)

#### EARLY WARNING ON AGRICULTURAL PRO-DUCTION WITH SATELLITE DATA AND SIM-ULATION MODELS IN ZAMBIA.

M. Menenti, J. Huygen, S. Azzali, and J. A. A

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. World Bank Publications, Washington, DC. 1990. p 187-206, 7 fig, 3 ref.

Descriptors: \*Crop production, \*Cultivated lands, \*Mapping, \*Model studies, \*Remote sensing, \*Satellite technology, \*Zambia, Agricultural engineering, Crop yield, Cropland, Data acquisition, Developing countries, Forecasting, Surveys, Tropical regions

The concept of food security can be defined as an integrated plan to provide sufficient food for the

whole population in both the short and the long term and to ensure that equal attention is paid to sustainable domestic production, consumption, processing, distribution, and food reserves. The regular use of remotely-sensed information, especially in tropical countries such as Zambia, helps meet the information requirements of crop monitoring systems. The current early warning network toring systems. The current early warning network in Africa lacks an interface between the geographical reference units at the global and regional level and the units of the national level, and lacks an interface between the crop-specific input data required at the national level and the undifferentiated output data provided at the global and regional levels. The MARS project (Monitoring Agroecological Resources using Remote Sensing and Simulation) has been proposed to improve the estimation of the senting of the senting and simulation. logical Resources using Remote Sensing and Simulation) has been proposed to improve the estimation of the actual hectarage of the total cultivable area and the total planted areas under specificrops, making use of high resolution images, and the assessment of yields of the important crops in the identified agroecological zones in Zambia. Introduction of low resolution remote sensing procedures will improve rainfall estimation and the determination of the start of the growing season, and implementation of a crop-specific simulation model will take into account the actual weather conditions. MARS aims at the establishment of a linkage will take into account the actual wearner condi-tions. MARS aims at the establishment of a linkage between the data provided by meteorological satel-lites, Meteosat and NOAA, and the operational requirements of crop yield forecasting and moni-toring at the national level. The system will im-prove the real-time information on the crop-specific production per major agroecological zone in Zambia. (See also W91-10084) (Fish-PTT) W91-10100

INSTITUTIONAL ASPECTS OF REMOTE SENSING AND ENVIRONMENTAL DATA MANAGEMENT ISSUES AND RECOMMEN-DATIONS.

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div. F. Falloux

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128. rld Bank Publications, Washington, DC. 1990.

Descriptors: \*Data requirements, \*Developing countries, \*Environmental policy, \*Madagascar, \*Mapping, \*Planning, \*Remote sensing, \*Satelite technology, Data collections, Information systems, Interagency cooperation, Land management, Management planning, Resources management.

There is a huge gap between the extremely poor situation of existing agricultural and environmental data systems in clinet countries of the World Bank and the potential offered by modern technologies such as remote sensing. The case of Madagascar has been examined with respect to remote sensing and environmental data systems and the expected and environmental data systems and the expected future in the context of an environmental project that is being prepared. The current institutional framework of Madagascar regarding remote sensing, mapping, and natural resource data involves a number of agencies, and, as a whole, suffers from lack of clear-cut responsibilities, lack of institutional coordination, lack of sufficient funding, piecemeal and uncoordinated approaches by the donors, lack of access to existing data, lack of data integration, insufficient training (quantity and quality), cumbersome legal systems, supply-driven rather than demand-driven approach, and loss of data. Implementation of the Environmental Action Plan (EAP) is intended to correct these deficiencies, by revamping the mapping, remote sensing, and envi-ronmental data of Madagascar. Its expected features are to consolidate mapping, aerophotogrammetric, and geodetic activities; operation of a na-tional lab for satellite remote sensing; computeriza-tion of records; operation of a central computertion of records; operation of a central computer-ized information center; establishment of an overall agency network; agency program support; and ne-gotiation of long-term twinning arrangements with a mapping and remote sensing agency from a de-veloped country. The Malagasy case shows the need for strong donor coordination, a consensus with the government on what needs to be done for

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revamping the environmental database, and a longterm commitment to support this effort. A special action plan is needed for all of Africa, composed of four phases: helping countries assess their current situations; preparing a long-term program; prepara-tion of a detailed first program of investment; and financing this investment program to include long-term commitment. (See also W91-10084) (Fish-PTT) W91-10101

EFFICIENT INVESTMENT FOR DEVELOP-ING REMOTE SENSING ACTIVITIES.

IN: C. Cazaux.

IN: Satellite Remote Sensing for Agricultural Projects. World Bank Technical Paper No. 128.

World Bank Publications, Washington, DC. 1990. p 217-224.

Descriptors: \*Decision making, \*Developing countries, \*Project planning, \*Remote sensing, \*Satellite technology, Computers, Data acquisition, Data requirements, Education, Information systems, Management planning, Technology transfer.

One of the key requirements in enhancing the use and application of remote sensing, especially in developing countries, is that decision-makers who are to use the data must be fully involved in both project design and product development. The following steps should be taken before any important technical intervention (i.e. realization of large-scale projects) or hardware investment (station, processing system): (1) project design (identification/feasibility nhase use of existing remote sensing data): bility phase use of existing remote sensing data); (2) installation of receiving stations (preliminary studies); (3) remote sensing data processing systems (e.g., digital analyzers, microprocessors, computer image enhancers, microcomputers); and (4) educa-tion, training, and transfer of technology (national or regional remote sensing centers). Remote sensing is a fresh new technology with numerous technical and economic implications in many development programs and in various topics. The way in which this technique is incorporated requires deliwhich this technique is incorporated requires deli-cate choices because of human and financial invest-ments. Costs are often negligible in comparison with overall project costs, but errors can be uni-versally damaging. A preliminary analysis of the best conditions for incorporation of this technique is indispensable. (See also W91-10084) (Fish-PTT) W91-10102

ONCHOCERCOSE, HYDROLOGY AND SAT-ELLITE TELEMETRY (ONCHOCERCOSE, HY-DROLOGIE ET TELETRANSMISSION).

Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France).
For primary bibliographic entry see Field 5G.
W91-10126

COLLECTING, PROCESSING, STORAGE AND ANALYSIS OF SELECTED HYDROLOGICAL DATA IN SWITZERLAND.

Service Hydrologique National, Bern (Switzer-

land).
M. Spreafico.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 279-288, 6 fig, 11 ref.

Descriptors: \*Data acquisition, \*Data interpreta-tion, \*Data quality control, \*Hydrologic data, \*Hydrologic data collections, \*Research priorities, Switzerland, Catchment areas, Data collections, Data requirements, Discharge measurement, Hydrologic properties, Runoff, Sediment transport, Water level, Water quality management, Water

State-of-the-art reports on the different components of the water cycle have been prepared in recent years on the basis of the long series of hydrological and hydrometeorological measurements available in Switzerland, including experience gained from them in the fields of data collection, processing, and analysis. Some of the reports defined deficiencies and suggestions for future ac-

tivities. The real-time management of water re-sources and the establishment of viable runoff fore-casts demand knowledge of the actual water level sources and the establishment of viable runoff fore-casts demand knowledge of the actual water level or runoff values. The future work of collecting, processing, and storing data on water levels and runoff should be organized to include development of the measuring network in small catchment areas, of new methods of measurement, of automatic stations with remote control data transfer, determi-nation of the comparability of measuring equip-ment and methods, implementation of sophisticated studies concerning measurement investigations, and further development of programs for statisti-cally analyzing data from the data bank. Recom-mendations for future action in the field of sedi-ments from research stations, a projected conveyor belt bed load trap station, the standardization of equipment and methods for measuring suspended load, the standardization of the methods of analysis and processing the suspended load, the periodic and processing the suspended load, the periodic implementation of additional delta and lake bottom surveys and the concerted measurement of sedisurveys and the concerted measurement of sedi-ment loads. In order to protect the quality of the water, the following work must be carried out-continued operation of stations at selected sites, continued development of measuring instruments and methods, clear definition of individual ele-ments, measurement of individual pollutant parameters, and recording of the nutrient balance and more geochemical parameters in hydrological re-search catchments. (See also W91-10103) (Fish-PTT) W91-10130

AUTOMATIC ASSESSMENT OF RAINFALL AND ITS EVALUATION-EXPERIENCE IN THE FEDERAL REPUBLIC OF GERMANY. Stuttgart Univ. (Germany, F.R.). Inst. fuer

For primary bibliographic entry see Field 2B. W91-10145

ADVANCES IN TECHNOLOGY IN HYDROLO-GY-A VIEW FROM THE UNITED KINGDOM. R. W. Herschy. IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 487-499, 8 fig, 1 tab, 3 ref.

Descriptors: \*Data acquisition, \*Hydrologic data collections, \*Instrumentation, \*Measuring instruments, \*Microcomputers, \*Remote sensing, \*Satelite technology, \*Telemetry, \*United Kingdom, Areal precipitation, Data processing, Forecasting, Hydrologic data, Logging, Stream gages, Technology

Many advances in hydrological methods and in-strumentation have taken place in recent years, due in large part to microelectronic technology. Some of these are still in the experimental stage, some in the pre-operational stage, but others can now be considered as operational. The most significant adconsucreu as operational. In e most significant advance has been made in data collection, which in many countries is the major cost area in hydrology. New methods of data collection include the optical shaft encoder and the solid state logger optical shaft encoder and the solid state logger with take-away memory. New methods of stream-flow gaging include ultrasonic and electromagnetic methods, and a 'one-pass' current meter. Weather radar, in association with a computer, allows data processing to provide areal totals of precipitation. Satellite remote sensing applications to hydrology include simple qualitative observations, quantitative measurement of drainage networks, and point measurement correlations. Combination of satellite technology, with weather scalar enables precipits. technology with weather radar enables precipitation to be determined on an areal basis as well as forecasting the movement of storms. Advances in torecasting the movement of storms. Advances in telemetry and data processing allow automatic retrieval of current rainfall and river levels for operational purposes including flood warning; a hydrometric archiving system enabling retrieved historic data to be automatically processed and archived; a flow forecasting system whereby flow forecasting models can be run on a real-time basis; and a system of operating river management models on a real-time basis with or without associated control functions. Means of transmission is by line, radio,

or satellite. The power of modern microcomputers allied to their tolerance of a range of environmental conditions can provide a viable alternative to mainframe processing and can facilitate the intro-duction of a data processing and archiving capabil-ity into regions where computer usage has previ-ously been impractical. (See also W91-10103) (Fish-PTT)

NEW TECHNOLOGY FOR HYDROLOGICAL DATA ACQUISITION AND APPLICATIONS. Agricultural Research Service, Beltsville, MD. Hydrology Lab.

Hydrotogy A. Rango.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 511-517, 10 ref.

Descriptors: \*Data acquisition, \*Data storage and retrieval, \*Data transmission, \*Hydrologic data collections, \*Instrumentation, \*Model studies, \*Remote sensing, \*Technology, Artificial intelligence, Automation, Expert systems, Geographical information systems, Hydrologic models, Microcomputers, Microwaves, Satellite technology, Sensors

In the future, remote sensing should play a domi-nant role in hydrological research and operations. mant role in hydrological research and operations. Emphasis will be on developing microwave techniques, improving sensor resolution from space, optimizing frequency of coverage and data delivery times, and integrating remote sensing and the data through geographical information systems. Conventional hydrological measurements will also Conventional hydrological measurements will also be upgraded through advances in automated data recording and transmission using 'meteor burst' technology and satellite data collection systems. These advances, combined with those in computer technology, will cause changes in hydrological modeling. Models will make increasing use of areal hydrological data as opposed to point data. The trend towards hydrological modeling using microcomputers should promote an emphasis on model simplicity as opposed to increasing complexity. Use of physically realistic parameter values in hydrological models will result. Artificial intelligence will be tuitized in hydrological modeling. Expert systems will be developed to assist model users in efficient model applications on new basins without having to involve the model developer. (See also having to involve the model developer. (See also W91-10103) (Author's abstract) W91-10149

PERFORMANCE EVALUATION OF EARTH-

Trautwein Soil Testing Equipment Co., P.O. Box 31429, Houston, TX 77231. For primary bibliographic entry see Field 5E. W91-10153

COASTAL DUNES AS INDICATORS OF ENVI-RONMENTAL CHANGE.

Port Elizabeth Univ. (South Africa). Dept. of Ge-

nary bibliographic entry see Field 2L. W91-10181

MEASUREMENT OF CURRENT VELOCITIES IN MACROPHYTE BEDS, Vienna Univ. (Austria). Inst. fuer Pflanzenphysio-

logie.
C. Machata-Wenninger, and G. A. Janauer.
Aquatic Botany AQBODS, Vol. 39, No. 1/2, p, February 1991. 4 fig, 2 tab, 31 ref.

Descriptors: \*Current meters, \*Flow measure-ment, \*Flowmeters, \*Macrophytes, \*Streamflow, \*Submerged plants, Flow pattern, Flow velocity, Streambeds, Water currents.

A propeller-type flowmeter to measure current velocities within beds of submersed macrophytes was modified to permit readings in a very small cross-section without disturbing the internal structure of macrophyte beds. The method is independ-

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ent of the type of species and of the outline of the plant stand. The dimensions of the instrument determine a smallest meaningful spatial distance be-tween two points of measurement of 0.05 m, which is accurate enough to measure changes in the flow pattern at the transition from the plant stand to the free water. Investigation of different plant species (Groendlandia densa, Potamogeton crispus and Ranuculus trichophyllus) showed this method to be sufficiently accurate to describe the transition between the plant stand and the unvegetated section of streams and channels. (Sand-PTT) W91-10202

EVALUATION AND APPLICATION OF DIAL-YSIS POREWATER SAMPLERS FOR MICRO-BIOLOGICAL STUDIES OF SEDIMENT-

WATER INTERFACES.
Zurich Univ. (Switzerland). Inst. of Plant Biology.
H. Brandl, and K. W. Hanselmann.
Aquatic Sciences AQSCEA, Vol. 53, No. 1, p 5573, 1991. 2 fig, 4 tab, 19 ref, append. Swiss National Science Foundation grant 3.520-0.83.

Descriptors: \*Biogeochemistry, \*Interstitial water, \*Lake sediments, \*Membranes, \*Samplers, \*Sediment sampling, \*Water sampling, Dialysis porewater samplers, Equilibrium diffusion technique, Microbiological studies, Sediment-water interfaces.

In sediment ecosystems, changes in concentration of microbial metabolites with increasing depth can be determined dependably and reproducibly using the equilibrium diffusion technique. Since the per-meation characteristics of the membranes employed are crucial, selecting the proper membrane requires knowledge about its behavior under conditions which prevail in the natural environment. Thirteen polymer sheets were evaluated, compar-ing permeation terms for biogeochemically relevant solutes, biodegradability, and mechanical strength. Cellulose-based dialysis membranes are most satisfactory when employed in low tempera-ture anoxic environments. For this membrane, corture anoxic environments. For this membrane, cor-rection terms were calculated to account for diffu-sion losses during retrieval and sampling. Optimal incubation times can now be predicted from ex-perimentally determined permeation coefficients for several porewater solutes. Dialysis porewater samplers (DPS) were successfully applied during more than 100 independent experiments for the collection of interstitial water from surface sedi-ments. DPS were used for water denths as deen as ments. DPS were used for water depths as deep as 290 meters. (Author's abstract) W91-10215

LEACHING OF METAL POLLUTANTS FROM FOUR WELL CASINGS USED FOR GROUND-WATER MONITORING. Cold Regions Research and Engineering Lab., Hanover, NH. A. D. Hewitt.

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A215 239. Price codes: A03 in paper copy, A01 in microfiche. Army Special Report 89-32, September 1989. 11p, 1 fig. 6 tab. 18 ref. append.

Descriptors: \*Leaching, \*Metals, \*Monitoring, \*Sample preservation, \*Sampling, \*Well casings, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Polymers, Polytetrafluoroethylene, Polyvinyl chloride, Selenium, Silver, Water

Polytetrafluoroethylene (PTFE), polyvinyl chloride (PVC), stainless steel 304 (SS 304) and stainless steel 316 (SS 316) well casings were tested for suitability for groundwater monitoring. A laboratory experiment, testing for the leaching of Ag, As, Ba, Cd, Cr, Hg, Pb, Se and Cu, was run in triplicate by exposing sections of the well casings to groundwater for four periods ranging from 1 to 40 days. The results showed that PTFE did not leach days. The results showed that PTFE did not leach any of the nine analytes studied, while SS 316 and PVC showed significant leaching of Cr, Cd and Pb; SS 316 also leached significant amounts of Ba and Cu. Stainless steel 304 showed significant leaching of Cr and Pb. In every case where contamination was observed, the release of metal ana-

lyte, when averaged over all of the exposure periods, was the greatest from either SS 304 or SS 316. Released contaminants were sorbed back onto the well casings in several cases. (See also W91-10247) (Author's abstract) W91-10236

PROCEDURES FOR GROUND-WATER INVES-TIGATIONS.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 7A. W91-10243

INFLUENCE OF WELL CASING COMPOSI-TION ON TRACE METALS IN GROUND

Cold Regions Research and Engineering Lab., Hanover, NH.

A. D. Hewitt. A. D. Hewitt.
Available from the National Technical Information
Service, Springfield, VA. 22161, as AD-A208 109.
Price codes: A03 in paper copy, A01 in microfiche.
Army Corps of Engineers Special Report 89-9,
April 1989. 18p, 2 fig. 6 tab, 12 ref, append. Army
Contract CETHA-TE-SR-89017.

Descriptors: \*Monitoring, \*Sample preservation, \*Sampling, \*Test wells, \*Trace metals, \*Well casings, Arsenic, Cadmium, Chemical analysis, Chronium, Hydrogen ion concentration, Lead, Organic carbon, Polytetrafluoroethylene, Polyvinyl chloride.

Experiments determined the concentration depend-Experiments determined the concentration depend-ence of trace inorganic priority pollutants (As, Cd, Cr and Pb) in groundwater solutions exposed to polyvinyl chloride (PtC), polytetrafluoroethylene (PTFE) and two types of stainless steel (S304 and S3316). The test design used a factorial screening matrix with two concentrations of metals (As-Crmatrix with two concentrations of metals (As-Crp-Pb, 50 and 10 microgm/L; Cd, 10 and 2 microgm/L), pH (5.8 and 7.7), and total organic carbon (natural and natural plus 5 mg/L humic acid) as variables. Samples containing well casings and controls without pipe sections were run as duplicates. Aliquots were removed from all of the solutions after 0.5, 4, 8, 24 and 72 hours. Aqueous metal concentrations were determined by graphite furnace atomic absorption spectroscopy. The results showed PTFE to have no significant influence on the metals monitored under any of the ence on the metals monitored under any of the ence on the metals monitored under any of the groundwater conditions. Metal concentrations in groundwater exposed to SS316 and SS304 had large random variances believed to be caused by surface oxidation of the stainless steel, PVC had a more active surface than PTFE in terms of both sorption of Pb and release of Cd. (See also W91-10236) (Author's abstract) W91-10247

DEVELOPMENT AND PRACTICAL TEST OF AN INSTRUMENT FOR EARLY RECOGNI-TION OF TOXIC INFLUENCES ON ANAERO-BIC WASTE WATER AND SLUDGE TREAT-MENT (ENTWICKLUNG UND PRAKTISCHE ERPROBUNG EINES GERATES ZUR FRU-HERKENNUNG SCHADLICHER EINFLUSSE AUF DIE ANAEROBE ABWASSER-SCHLAMMBEHANDLUNG).

Hanover Univ. (Germany, F.R.). Inst. fuer Sied-lungswasserwirtschaft und Abfalltechnik.

H. Ruffer, and K. Spiller.

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA. 22161, as TIBA 8882147. Price codes: A06 in paper copy, A01 in microfiche. Report No. BMFT FB, 1987. 75p, 25 fig, 4 tab, 25 ref. English summary.

Descriptors: \*Measuring instruments, \*Sludge treatment, \*Toxicity, \*Wastewater treatment, An-aerobic digestion, Chemical oxygen demand, Conductivity, Heavy metals, Hydrogen ion concentra-tion, Organic compounds, Oxidation-reduction po-tential, Performance evaluation, Wastewater treatment facilities.

A control and regulation unit for anaerobic degra-dation was designed and tested with laboratory experiments on the basis of microbial parameters known to be essential for anaerobiosis. These ex-

periments were carried out with industrial wastewater containing several types of toxicants, to find one or more parameters for early recognition of beginning toxicity. The gas production, related to the COD-load, was found to be the most sensitive parameter for toxicity. The qualifications of the parameters of redox potential and pH-value were found to be dependent upon the nature of the toxicants (heavy metals, organic toxicants, alkali salts, oxidizing reagents). Therefore, it was necessalts, oxidizing reagents). Therefore, it was necessary to measure more than one additional parameter, even though there was the chance that the toxicant could be recognized and selective sanitizing operations launched, instead of simply stopping the load. The measurement of conductivity was shown to be suitable for recognizing not only high alkali salt concentrations, but also for regulating the optimum range of COD-load. (Author's abstract) W91-10248

CLOUD COVER DETERMINATION IN POLAR REGIONS FROM SATELLITE IMAGERY.

Cooperative Inst. for Research in Environmental Science, Boulder, CO.

R. G. Barry, and J. Key.

Available from the National Technical Information Service, Springfield, VA. 22161, as N90-13003. Price codes: A12 in paper copy, A01 in microfiche. Final Report, December 15, 1989, 262p, 6 fig, 58 ref, 5 append. NASA Grant NAG-5-898.

Descriptors: \*Climatology, \*Cloud cover, \*Clouds, \*Meteorology, \*Polar regions, \*Remote sensing, \*Satellite technology, Albedo, Data interpretation, Digital map data, Infrared imagery, Mapping, Model studies, Statistical analysis,

To evaluate the effectiveness of the International Satellite Cloud Climatology Project (ISCCP) algorithm for cloud retrieval in polar regions, it was necessary to develop a suitable validation data set to identify the limitations of current procedures and to explore potential means to remedy them using textural classifiers, and to compare synoptic cloud data from model runs with observations. Toward the first goal, a polar data set consisting of visible, thermal, and passive microwave data was developed. AVHRR and SMMR data were digitally merged to a polar stereographic projection with an effective pixel size of 5 sq km. With this data set, two unconventional methods of classifying the set, two unconventional methods of classifying and imagery for the analysis of polar clouds and sur-faces were examined: one based on fuzzy sets theory and another based on a trained neural network. Both were compared to the maximum likeli-hood procedure and were found to provide additional flexibility in the analysis of polar clouds in that the inherently fuzzy boundaries between cloud and surface classes in spatial and spectral space are acknowledged. An algorithm for cloud detection was developed from an early test version of the ISCCP algorithm, which includes the identification of surface types with passive microwave, then tion or surface types with passive microwave, then temporal tests at each pixel location in the cloud detection phase. Cloud maps and clear sky radiance composites for 5-day periods are produced. Algorithm testing and validation was done with both actual AVHRR/SMMR data, and simulated integers. Even this copie in the algorithm groups. imagery. From this point in the algorithm, groups imagery. From ins point in the algorithm, groups of cloud pixels are examined for their spectral and textural characteristics, and a procedure is developed for the analysis of cloud patterns utilizing albedo, IR temperature, and texture. This procedure abandons the traditional method of gridding an image and classifying the grid cells in favor of assigning a local texture value to each pixel. The spectral and textural characteristics are used in a supervised classification of mesoscale (250 km) cloud patterns without artificially imposed boundaries. (Lantz-PTT) W91-10251

HAZARDOUS WASTE SITE CHARACTERIZA-TION UTILIZING IN SITU AND LABORATO-RY BIOASSESSMENT METHODS.

Corvallis Environmental Research Lab., OR. For primary bibliographic entry see Field 5A. W91-10258

### Data Acquisition—Group 7B

SLURRY-METER FOR ESTIMATING DRY MATTER AND NUTRIENT CONTENT OF STUDDY

Castle Research Centre, Johnstown Johnstown (Ireland). H. Tunney

In: Long-Term Effects of Sewage Sludge and Farm Slurries Applications. Elsevier Applied Science Publishers, London. 1985. p 216-223, 4 fig, 4

Descriptors: \*Dry matter, \*Hydrometers, \*Measuring instruments, \*Nutrients, \*Slurries, Animal wastes, Data acquisition, Field tests, Nitrogen, Phosphorus, Potassium, Specific gravity.

In studies of the composition of animal slurry, it was found that there is a good positive correlation between dry matter and plant nutrient content. In further studies to obtain a simple field test to estimate dry matter, it was found that there was a highly significant straight line relationship between highly significant straight line relationship between specific gravity and dry matter of animal slurries. Based on this relationship, a patented hydrometer, calibrated in percent dry matter, was developed. This can be used under field conditions to get a rapid estimate of the dry matter of slurry, and the corresponding nitrogen, phosphorus and potassium content for the slurry can be read from an accompanying table. To date, several hundred of these Slurry Meters have been manufactured and distributed. The practical experience to date with the slurry meter indicates that it is a simple to use uted. The practical experience to date with the slurry meter indicates that it is a simple to use method for estimating dry matter and fertilizer value of slurry. It is particularly valuable for estimating the quantity of slurry to apply to meet crop needs and for deciding on a price when buying or selling slurry. The feedback from people who have used the slurry meter has been positive. (See also W91-10290) (Author's abstract)

CHEMICAL FORMS AND REACTIVITIES OF METALS IN SEDIMENTS.

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik. For primary bibliographic entry see Field 5B. W91-10292

REASONS TO USE NEUTRAL SALT SOLU-TIONS TO ASSESS THE METAL IMPACT ON PLANT AND SOILS.

For primary bibliographic entry see Field 5B. W91-10294

EVALUATION OF CHEMICAL METHODS FOR ASSESSING THE CD AND ZN AVAIL-ABILITY FROM DIFFERENT SOILS AND SOURCES.

Brunswick (Germany, F.R.). Inst. fuer Pflanzener-naehrung und Bodenkunde.

For primary bibliographic entry see Field 5B. W91-10295

OPERATIONAL AIRBORNE MEASURE-MENTS OF SNOW WATER EQUIVALENT AND SOIL MOISTURE USING TERRESTRIAL GAMMA RADIATION IN THE UNITED

National Weather Service, Minneapolis, MN. Office of Hydrology. For primary bibliographic entry see Field 2C. W91-10357

DETERMINATION OF WATER EQUIVALENT OF SNOW AND THE FORECAST OF SNOW-MELT RUNOFF BY MEANS OF ISOTOPES IN

State Hydraulic Works, Ankara (Turkey). Technical Research and Quality Control Dept.
For primary bibliographic entry see Field 2C.

REMOTE SENSING OF SNOW. Innsbruck Univ. (Austria). Inst. fuer Meteorologie und Geophysik.

For primary bibliographic entry see Field 2C. W91-10362

DISCUSSION OF THE ACCURACY OF NOAA SATELLITE-DERIVED GLOBAL SEASONAL SNOW COVER MEASUREMENTS, Satellite Hydrology, Inc., Vienna, VA For primary bibliographic entry see Field 2C. W91-10363

REMOTE SENSING OF SNOW CHARACTERISTICS IN THE SOUTHERN SIERRA NEVADA. California Univ., Santa Barbara. Center for Remote Sensing and Environmental Optics. For primary bibliographic entry see Field 2C. W91-10364

ANALYSIS OF INTERANNUAL VARIATIONS OF SNOW MELT ON ARCTIC SEA ICE MAPPED FROM METEOROLOGICAL SATEL-LITE IMAGERY.

Lamont-Doherty Geological Observatory, Pali-For primary bibliographic entry see Field 2C. W91-10365

SNOW MELT ON SEA ICE SURFACES AS DE-TERMINED FROM PASSIVE MICROWAVE SATELLITE DATA. Scripps Institution of Oceanography, La Jolla, CA.

For primary bibliographic entry see Field 2C. W91-10366

ESTIMATING SNOWPACK PARAMETERS IN THE COLORADO RIVER BASIN.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2C. W91-10367

SNOW COVER PARAMETER RETRIEVAL FROM VARIOUS DATA SOURCES IN THE FEDERAL REPUBLIC OF GERMANY. Cooperative Inst. for Research in Environmental

Science, Boulder, CO.
For primary bibliographic entry see Field 2C.
W91-10368

DISTRIBUTION OF SNOW EXTENT AND DEPTH IN ALASKA AS DETERMINED FROM NIMBUS-7 SMMR MAPS (1982-83).

National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch. For primary bibliographic entry see Field 2C. W91-10372

BIDIRECTIONAL REFLECTANCE OF SNOW AT 500-600 NM. Cooperative Inst. for Research in Environmental

Science, Boulder, CO.
For primary bibliographic entry see Field 2C.
W91-10373

REMOTE SENSING OF BIOSPHERE FUNC-TIONING.

Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. 312p. Edited by R. J. Hobbs and H. A. Mooney.

Descriptors: \*Biological communities, \*Biological data, \*Biosphere, \*Data acquisition, \*Ecological data, \*Remote sensing, \*Satellite technology, Cortelation analysis, Data transmission, Ecotypes, Infrared imagery, Pigments, Radiation, Vegetation.

In July 1988, a joint U.S.-Australia workshop was held to review current progress and point to new directions for the future in remote sensing. Scien-tists met from both countries to address a number of specific problems, focusing on the kinds of functional properties that can now be monitored from aircraft and space, the system generality of currently available sensing information, and the

kinds of experiments, measurements, or that will be required to improve the capability to continuously measure biosphere function. The monitoring of individual environmental factors driving biological processes and chemical features of the biotic system that control function were examined. Further, the remote sensing of the actual processes central to biosphere functioning: the exchanges of carbon, water, and trace gases were examined. Finally, the remote sensing of were examined. Finally, the remote sensing of vegetation and landscape processes were analyzed. The basis for assessments of the structure and function of biological features of the earth's surface is the information contained in the reflectance of radiation of specific spectral regions. Pigments differentially absorb visible radiation, as does water in the short-wave infrared region. Reflectance in the near infrared is related to leaf structural characteristics. Thus spectral information can yield correlative assessments of structural and functional feature assessments of structural and functional feature assessments of structural and functional feature assessments of structural and functional features. tive assessments of structural and functional fea-tures of vegetation relating to these characteristics, such as plant productivity and stress status. Good correlations have been made between absorbance in various visible bands and phytoplankton biomass and primary productivity. Developments utilizing satellite-derived measures of surface sea temperature and wind-induced mixing hold promise of refining these correlations. Thirteen papers discussing these various aspects of remote sensing are included in the volume. (See W91-10375 thru W91-10387) (White-Reimer-PTT) W91-10374

REMOTE SENSING OF TERRESTRIAL ECO-SYSTEM STRUCTURE: AN ECOLOGIST'S PRAGMATIC VIEW.

Commonwealth Scientific and Industrial Research Organization, Lyneham (Australia). Div. of Wildlife and Rangelands Research.

R. D. Graetz. In: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 5-30, 6 fig, 1 tab, 82 ref.

Descriptors: \*Biological data, \*Data acquisition, \*Ecological data, \*Remote sensing, \*Satellite technology, Ecological distribution, Mapping, Vegeta-

The scientific concepts involved in the application of remote sensing technology to current and future problems in terrestrial ecology are reviewed. Topics covered include: (1) determining future re-Topics covered include: (1) determining future requirements by asking the questions why, when, and where; (2) consideration of the vegetation component of ecosystems by means of physiognomy, dynamics, and taxonomic description; (3) the structure of vegetation through classification and description; (4) problems in the collection and interpretation of remotely sensed data; and (5) present methods and their limitations such as image processing models, vegetation indices, estimation of vegetative cover, sectral dimension and caliof vegetative cover, spectral dimension, and cali-bration. In order to understand the behavior of the biosphere and its interaction with the atmosphere, ecologists must understand data collection by remote sensing, and acquire a working familiarity with the spectral, spatial, and temporal dimensions of current and future earth-observing systems. (See also W91-10374) (White-Reimer-PTT) W91-10375

MEASUREMENTS OF SURFACE SOIL MOIS-

TURE AND TEMPERATURE.
Agricultural Research Service, Beltsville, MD.
Hydrology Lab.

T. Schmugge.

IN: Remote Sensing of Biosphere Functioning.

Ecological Studies 79. Springer-Verlag New York,

Inc., New York. 1990. p 31-63, 16 fig,1 tab, 50 ref.

Descriptors: \*Data acquisition, \*Remote sensing, \*Satellite technology, \*Soil temperature, \*Soil \*Satellite technology, \*Soil temperature, \*Soil water, Infrared radiation, Microwaves, Model studies, Monitoring.

The monitoring of the energy and moisture fluxes between the soil and the atmosphere as well as of the water budget of the root zone in the soil is recognized as important for applications ranging

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from the study of biospheric processes at local scales (10s of meters) to the modeling of atmospheric behavior at regional scales (10s of kilometers). Measurement of the thermally emitted radiation at various wavelengths from the earth's surface can yield useful estimates of surface soil moisture and temperature. The basic principles for the remote sensing of these two parameters have been reviewed. The two techniques used are thermal infrared and microwave sensing. The combined measurements or estimates of these parameters can be used with coupled moisture and energy balance models to describe the fluxes from the surface. Microwave sensing has the ability to measure the moisture content of a surface layer about 5 cm thick to a relative accuracy of 10% and 15%. Advantages include the fact that measurements can be made under all weather conditions and through light to moderate vegetation conditions, and that face can yield useful estimates of surface soil moislight to moderate vegetation conditions, and that the factors of surface roughness and soil texture which introduce uncertainties into the soil moisture determinations can be mostly accounted for with ancillary data. Thermal infrared using either the split-window approach or some ancillary knowledge of the atmospheric profiles can estimate the surface radiant temperature to an accuracy of I or 2 C. One of the major advantages of microwave remote sensing is its ability to observe the land surface in almost any atmospheric condition. (See also W91-10376) (White-Reimer-PTT) W91-10376

ESTIMATING TERRESTRIAL PRIMARY PRO-DUCTIVITY BY COMBINING REMOTE SENS-ING AND ECOSYSTEM SIMULATION.

Montana Univ., Missoula. School of Forestry

Montana Univ., Missoula. School of Forestry. S. W. Running. IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 65-86, 8 fig, 60 ref. NASA Earth Sciences and Applications Division Grant NAGW-252.

Descriptors: \*Ecosystems, \*Model studies, \*Primary productivity, \*Remote sensing, \*Satellite technology, Canopy, Carbon, Mapping, Nitrogen,

Two current methodologies being developed for estimation of primary production of natural vege-tation are Advanced Very High Resolution Radi-ometer/Normalized Difference Vegetation Index (AVHRR/NDVI (remote sensing)) and the linking of satellite data with ecosystem process models. Although the AVHRR/NDVI has rapidly evolved into an indispensable tool for monitoring global net primary production (NPP), it is not satisfactory for all purposes. The results represent ecophysiological processes in only a simple empiri-cal way, leaving it unsuited for exploring sensitive feedbacks and multifactor controls on NPP in an explicit manner. In addition, dynamic sensitivity is lost when the approach is applied to biomes such as coniferous forests that provide a temporally inert remote sensing target. The second approach incorporates remote sensing of leaf area index (LAI) with ecosystem simulation models. The model (FOREST-BGC) has mixed time resolumouet (FORES) 1-BOC) has mixed time resolu-tions, with hydrologic and canopy gas-exchange processes computed daily and carbon and nitrogen cycle processes computed yearly. The model was designed to be particularly sensitive to LAI be-cause LAI can be retrieved by satellite. Ultimate validation requires simulation of the variable of interest compared with direct ground measurement across a range of conditions. A number of spatially ntegrating measurement systems are under development that may allow direct measurement of vegetation gas-exchange rates at intermediate scales. (See also W91-10374) (White-Reimer-PTT)

REMOTE SENSING OF LITTER AND SOIL

REMOTE SENSING OF LITTER AND SOIL ORGANIC MATTER DECOMPOSITION IN FOREST ECOSYSTEMS.

New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space.

J. D. Aber, C. A. Wessman, D. L. Peterson, J. M. Melillo, and J. H. Fownes.

IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York,

Inc., New York. 1990. p 87-103, 7 fig, 42 ref. append. NSF grant BSR-8317531 and NASA-Ames Research Center NCA-2-28.

Descriptors: \*Decomposition, \*Forest ecosystems, \*Litter, \*Remote sensing, \*Satellite technology, Canopy, Correlation analysis, Evapotranspiration, Lignin, Nitrogen, Organic matter.

A brief review of the factors controlling decomposition in forest ecosystems and the potential for estimating rates of decay by remote sensing is presented. Combinations of a few key parameters, presented. Combinations of a few key parameters, susually nitrogen and lignin content, have been found to predict both weight loss and nutrient dynamics for a wide range of litter types. Decay rates of fresh litter also show a strong relationship with climate. Multiple regression equations have been developed that predict early litter decay rates as a function of litter quality (lignin content) and climate (summarized as actual evapotranspiration, AET). These results suggest that estimates of foliar litter decay rates could be made from remote sensing data if lignin and nitrogen content of produced litter could be predicted with some accuracy. A case study was conducted to determine whether differences in the lignin and nitrogen content of whole canopies from a diverse set of well-studied forest ecosystems could be detected and predicted using spectral reflectance data from imaging spectrometers, and whether those differences related to field measured rates of nitrogen mineralization. Statistically, the accurate prediction of lignin con-centration for canopies of very different species composition and foliar morphology and chemistry suggests that the remote sensing results are generalizable, at least across temperate forest ecosys-tems. However, theoretical support for this rela-tionship is lacking, as the near-IR absorption spec-trum for lignin, a large, amorphous aromatic polymer with variable structure, is not yet well defined mer with variable statements ensing of important canopy chemical features is feasible. Predicting rates of important ecosystem processes from remotely sensed data is less certain, and depends on strong correlations between canopy variables and the process of interest. (See also W91-10374) (White-Reimer-PTT) W91-10378

WATER AND ENERGY EXCHANGE. National Center for Atmospheric Research, Boulder, CO. R. E. Dickinson.

IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 105-133, 11 fig, 89 ref.

Descriptors: \*Climatology, \*Data acquisition, \*Energy, \*Hydrologic models, \*Hydrology, \*Metorological data, \*Model studies, \*Remote sensing, \*Satellite technology, Air temperature, Atmospheric water, Climates, Humidity, Microwaves, Radiation, Rainfall, Vegetation.

Obtaining water and energy exchange on continen-tal scales from remote sensing is fundamental to the questions not only of ecosystem functioning but also of land climate processes and regional hydrology. An optimum approach to water and energy exchange at the land surface involves com-bining several kinds of observations with an appro-priate modeling framework. Observations known to contain information about water and energy fluxes are radiative skin temperatures over the diurnal cycle; rainfall; divergence of moisture flux in an atmospheric column; descriptions of the surface vegetation cover in terms of parameters that affect evapotranspiration and surface albedo, and likewise for soils and terrain in terms of their effects on surface hydrology; any direct measures of soil moisture that are possible such as can be inferred from microwave emissivities; all the observations needed for an atmospheric model to provide adequate surface air temperatures, winds, and relative humidity; and adequate information on atmospheric cloud, aerosol, and humidity structure to estimate surface incident solar and longwave to estimate surrace incident solar and longwave radiation. Partial approaches to estimating surface water and energy fluxes are possible by using subsets of this information. An integrated approach using General Circulation Models (GCMs) linked

to remote sensing expedited by the use of the same physical process algorithms is recommended. (See also W91-10374) (White-Reimer-PTT) W91-10379

EVALUATION OF CANOPY BIOCHEMISTRY. Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space. C. A. Wessman.

IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 135-156, 6 fig, 102 ref.

Descriptors: \*Biochemical data, \*Canopy, \*Data acquisition, \*Forest ecosystems, \*Remote sensing, \*Satellite technology, \*Spectral analysis, Biochemistry, Climates, Infrared imagery, Instrumentation, Reflectance, Vegetation.

The capability to detect changes in canopy biochemistry using remote sensing would provide a means of assessing spatial extent and variation of carbon/nutrient sources and sinks crucial to understanding gas exchange between vegetation and the atmosphere. Research in analytical chemistry has demonstrated that concentrations of constituents within organic mixtures can be evaluated from near-infrared (IR) reflectance spectra of those mixtures. With the advent of imaging spectrometry, research has focused on the application of spectroscopy principles to remotely sensed data in the effort to resolve information on subtle spectral features relevant to ecosystem functioning. potential to estimate canopy constituents remotely rests on (1) the overall canopy reflectance curve, and (2) the development of high spectral resolution instruments that will measure the reflectance signal instruments that will measure the reflectance signal at sufficient detail and quality to document subtle changes in spectral shape and allow reduction of environmental/sensor effects using spectral analysis techniques. The technology to acquire high spectral images is limited to only a few airborne systems. These will provide the prototype data for proposed instruments on the Earth Observing System, an orbiting platform of sensors designed to provide continuous remotely sensed data at regional to global scales. Estimates of canopy biochemistry through direct assessment of spectral reflecnce features or inferred through relationships with other factors contributing to canopy reflec-tance (e.g., water content) will provide further insight into the nature of biosphere function response to environmental change. (See also W91-10374) (White-Reimer-PTT) W91-10380

REMOTE SENSING AND TRACE GAS FLUXES.

National Aeronautics and Space Administration.

National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center. P. A. Matson, and P. M. Vitousek. IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 157-167, 2 fig, 31 ref.

Descriptors: \*Data acquisition, \*Gases, \*Remote sensing, \*Satellite technology, \*Trace gases, Ammonia, Carbon monoxide, Hydrocarbons, Methane, Model studies, Monitoring, Nitrous oxide, Sulfur.

Fluxes of trace gases represent an important inter-action between the biosphere and atmosphere. The major trace gases of interest include methane, major trace gases of interest include methane, carbon monoxide, nonmethane hydrocarbons, ni-trous oxide, other oxides of nitrogen, ammonia, and various sulfur-containing trace gases. Ultimate-ly, remote measurements are essential to the develment of regional estimates of trace gas flux. The opment of regional estimates of trace gas into a me least adventurous way to use remote sensing in developing estimates of trace gas flux is to classify ecosystems into functionally different units that ecosystems into tunctionally different units that can be distinguished remotely, then to measure fluxes of trace gases on the ground in each of those units, and, finally, to make an areal estimate of flux by multiplying the cover of each type by the flux from that type. A second approach is to use remote sensing to drive biogeochemical models of terrestrial ecosystems, which, in turn, predict fluxes of

#### Data Acquisition—Group 7B

trace gases. A number of ground-based techniques can be used to determine the concentrations or fluxes of trace gases; these include tower-based eddy correlation systems, light detection and rang-ing laser systems, the multipass tunable diode laser system and Fourier transform infrared spectrosco-py. It is thought that aircraft-based systems cur-rently offer the greatest potential for the applica-tion of remote sensing to estimating fluxes of trace gases. Aircraft have the mobility and flexibility to gases. Aircraft have the motionity and instolinty to sample important areas at the appropriate time, and a number of new and exciting sensors are now mounted on aircraft. While satellite-based remote sensing is now extremely useful for deriving correlates of trace gas flux and drivers for models of trace gas flux, it cannot be used to measure fluxes directly. (See also W91-10374) (White-Reimer-PTT) W91-10381

#### SATELLITE REMOTE SENSING AND FIELD EXPERIMENTS.

Maryland Univ., College Park. Dept. of Meteorol-

ogy.
P. J. Sellers, F. G. Hall, D. E. Strebel, G. Asrar, and R. E. Murphy.
IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York. Inc., New York. 1990. p 169-201, 12 fig, 2 tab, 36

Descriptors: \*Biological data, \*Biosphere, \*Ecological data, \*Field tests, \*Model studies, \*Remote sensing, \*Satellite technology, Atmosphere, General circulation models, Heat transfer, Humidity, Monitoring, Precipitation, Succession, Temperature, Wind.

The study of land surface biota on global and regional scales automatically implies a study of the interactions between the biosphere and the atmospheric environment. The mismatch of scales between the biological and meteorological communities has brought about a division of biosphereatmosphere modeling studies into two distinct categories. The first is the modeling of predominantly biophysical interactions between the terrestrial surface and the atmosphere, where the principle ob-jective is to simulate realistically the biological, physical, and dynamic processes that govern the motion of the atmosphere and thereby calculate the time evolution of the three-dimensional fields of temperature, humidity, wind speed, relative flux of temperature, numonly, wind speed, relative flux divergence, and precipitation. The primary tool for this kind of study is the atmospheric General Circulation Model (GCM), that incorporates the primitive equations describing the motion of the atmosphere in terms of fluid dynamics, and mathematical descriptions of the important one-dimensional abusing precesses that temperature and provided the process of the comparison of the important one-dimensional abusing precesses that temperatures. sional physical processes that transfer heat, mass, and momentum throughout the atmospheric column. The second category of biosphere-atmosphere model addresses the issue of successive changes in community composition and structure (CCS) over periods of decades to millennia. Generally speaking, these models regard the atmosphere purely as a source of applied forcing and do not consider any feedback effects from the surface back to the atmosphere. Satellite remote sensing ouck to the atmosphere. Satelifte remote sensing can play a significant role in the investigation of biosphere-atmosphere interactions for both biophysical models and ecosystem succession models. Both categories of model require observations for initialization and for validation. (See also W91-10349) (White-Reimer-PTT)

# REMOTE SENSING OF SPATIAL AND TEM-PORAL DYNAMICS OF VEGETATION. Commonwealth Scientific and Industrial Research Organization, Lyneham (Australia). Div. of Wild-

and Ecology.

In: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 203-219, 5 fig, 94 ref.

Descriptors: \*Mapping, \*Remote sensing, \*Satellite technology, \*Vegetation, Climates, Community structure, Data acquisition, Data processing, Forests, Seasonal variation, Succession.

Since vegetation is changing at a variety of spatial and temporal scales it is essential that the variability at one scale is taken into account when trying to interpret changes at another. The types of variability that should be considered are: (1) seasonal response; (2) interannual variability; and (3) directions of the considered are: tional vegetation which may be caused by succession, land-use and other human changes, and changes in global climate patterns. Remote sensing can quite accurately determine some or all differences in vegetation composition, structure, productivity, and 'health.' The resolution required depends on the type of problem being tackled. For large-scale (continental and global) investigations targe-scare (continents) and ground investigations the Advanced Very High Resolution Radiometer (AVHRR) provides the only viable source of data in terms of data-handling problems. Different types of vegetation and different situations require a variety of approaches. Of particular importance in considering vegetation mapping has been the development of vegetation or greenness indices such as the normalized difference vegetation index. More complex techniques of plant community rec-ognition and mapping are available that use all of the spectral data derived from satellites rather than dex derived from a subset of the data. Remote sensing has also been used successfully to detect large-scale vegetation changes brought about through deforestation or forest fires. (See also W91-10374) (White-Reimer-PTT) W91-10383

#### REMOTE SENSING OF LANDSCAPE PROC-

Commonwealth Scientific and Industrial Research Organization, Alice Springs (Australia). Div. of Wildlife and Rangelands Research. G. Pickup.

G. Pickup. In: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 221-247, 5 fig, 1 tab, 55

Descriptors: \*Data acquisition, \*Erosion, \*Geomorphology, \*Model studies, \*Remote sensing, \*Satellite technology, \*Soil erosion, Climates, Sediment transport, Spatial variation, Temporal

The use of remote sensing technology to describe, explain, and predict some of the geomorphic changes that may affect biological activity at a time scale of tens to hundreds of years was examined. Few of these properties can be measured directly but remotely sensed data can often prodirectly but remotely sensed data can often pro-vide useful surrogate information on both proper-ties and processes. Deriving these surrogates may require consideration of spatial or temporal varia-bility in the data rather than the single-scene approach now common. Landscape change may be sporadic and spatially discontinuous, making it dif-ficult to understand. Models that are widely acficult to understand. Models that are widely ac-cepted by geomorphologists are equilibrium-based and describe the relationships between landforms and the fluctuating climatic conditions that control their properties. Once an understanding of land-scape change is available, it may become possible to predict future change. One of the most active areas of research attempting to harness remote sensing to the prediction of landscape change is in soil erosion. A distributed model of sedimentation soil erosion. A distributed model of sedimentation processes in a landscape should describe four elements of behavior: (1) spatial and temporal variations in the sediment transport capacity of the system; (2) spatial and temporal variations in the supply of sediment that is available for transport; (3) the pattern of sediment redistributions. supply of sediment that is available for transport;

(3) the pattern of sediment redistribution that results where transport capacity and available load differ; and (4) the change in sediment supply or transport capacity at a point when sediment is eroded or deposited and system geometry or other characteristics are affected. (See also W91-10374) (White-Reimer-PTT) W91-10384

SYNOPTIC-SCALE HYDROLOGICAL AND BIOGEOCHEMICAL CYCLES IN THE AMAZON RIVER BASIN: A MODELING AND REMOTE SENSING PERSPECTIVE. Washington Univ., Seattle. School of Oceanogra-

J. E. Richey, J. B. Adams, and R. L. Victoria. IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 249-268, 5 fig, 44 ref. NSF

Descriptors: \*Amazon, \*Biochemistry, \*Geochemistry, \*Hydrologic models, \*Model studies, \*Remote sensing, \*Satellite technology, \*Tropical areas, Biogeochemistry, Catchment areas, Data acquisition, Deforestation, Forests, Hydrologic quisition, Defores budget, Hydrology.

Deforestation of tropical river basins is one of the primary variables in global change scenarios. The application of remote sensing to river basin proc-esses would seem to have particular potential in these difficult environments. A research strategy was developed combining field-data and remotely sensed data with modeling for determining the fluxes of water and elements in the Amazon River basin on synoptic scales (catchment and regional space scales of 100 to 500 km and time scales of 10 to 15 days). A regional model was developed that incorporated regional runoff, regional precipitainto portate in the properties of the properties ence/absence of primary forest; (2) the relative distribution of primary forest, regrowth, savannah, and scrub; and (3) the canopy architecture associand scrub; and (3) the canopy architecture associated with the different vegetation communities. Then the objective is to relate properties of the hydrological and biogeochemical cycles to these properties. The requirements for this approach include access to a series of three-dimensional fields derived from model output, geographic information systems, and near-simultaneous observations of the earth from the current and next generation of data sets. (See also W91-10374) (White-Reimer-PTT) W91-10385

### REMOTE SENSING OF MARINE PHOTOSYN-

Division of Fisheries, CSIRO Marine Laboratories, GPO Box 1538, Hobart 7000, Tasmania, Australia

J. S. Parslow, and G. P. Harris.

IN: Remote Sensing of Biosphere Functioning. Ecological Studies 79. Springer-Verlag New York, Inc., New York. 1990. p 269-290, 89 ref.

Descriptors: \*Marine environment, \*Model studies, \*Photosynthesis, \*Remote sensing, \*Satellite technology, Climates, Irradiance, Monitoring, Phytoplankton, Pigments, Productivity, Tempera-

Marine photosynthesis and climate change are potentially causally linked at a range of scales. Remote sensing can play a monitoring role, allowing the detection of changes in the distribution of phytoplankton biomass that are not apparent in point samples. Simple models that link parameters that may be observed remotely (predominantly surface pigment concentrations) to in situ photo-synthetic rates and the link between photosynthesis, other flux estimates, and climate change are reviewed. Satellites cannot be used to measure reviewed. Satellites cannot be used to measure fluxes such as photosynthetic rates directly. Therefore, it is necessary to relate the variable that can be measured, especially surface pigment concentrations (Ck), to fluxes of interest, such as depth integrated primary productivity (Pt). It should be possible to use other remotely sensed data such as sea surface temperature, solar irradiance, surface roughness, and wind speed to help predict Pt/Ck (and other flux ratios). This is essentially a modeling problem, whether it is tackled using simple empirical models or more complex realistic empirical models or more complex realistic models. The amount of effort and the type of measurements required will depend on the time and space scales at which predictive ability is sought. There are problems of bias in scaling up from sparse data: estimates of seasonal or annual production are better based on such techniques as oxygen balance and sediment traps which average over space or time. Success will depend on con-stant and conservative appraisal of the assumptions

#### Group 7B-Data Acquisition

and uncertainties associated with theoretical and empirical components. (See also W91-10374) (White-Reimer-PTT) W91-10386

ANALYSIS OF REMOTELY SENSED DATA. Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Mathematics and Statistics.

For primary bibliographic entry see Field 7C. W91-10387

#### QUANTITATIVE SYSTEMS METHODS IN THE EVALUATION OF ENVIRONMENTAL POLLUTION PROBLEMS.

Lancaster Univ. (England). Centre for Research on Environmental Systems.

For primary bibliographic entry see Field 5B. W91-10422

#### MINNESOTA PESTICIDE MONITORING SUR-VEYS: INTERIM REPORT.

Minnesota Dept. of Health, Minneapolis. For primary bibliographic entry see Field 5A. W91-10430

#### AUTOMATIC FEEDBACK CONTROL OF FURROW IRRIGATION,

Texas A and M Univ., College Station. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 3F.

SAMPLING OF SOILS, HERBAGE, ANIMAL MANURES AND SEWAGE SLUDGE FOR TRACE ELEMENT AND OTHER ANALYSES: IRISH EXPERIENCES.

Johnstown Castle Research Centre, Johnstown

For primary bibliographic entry see Field 5A. W91-10462

# SAMPLING AND ANALYSIS OF SLUDGES AND SOILS IN ENGLAND AND WALES FOR THE MANAGEMENT OF AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE.

Severn-Trent Water Authority, Birmingham (Eng-

For primary bibliographic entry see Field 5E. W91-10463

#### EXPERIENCES WITH SLUDGE SAMPLING IN THE RUHR RIVER BASIN.

For primary bibliographic entry see Field 5A. W91-10464

## SOIL SAMPLING FOR TRACE ELEMENT ANALYSIS AND ITS STATISTICAL EVALUATION,

Landwirtschaftlich-chemische Bundesanstalt, 4025 Linz, Austria

For primary bibliographic entry see Field 5A. W91-10465

#### PROBLEMS OF SAMPLING SOIL FAUNA FOR TERRESTRIAL ECOLOGICAL STUDIES. Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).

For primary bibliographic entry see Field 5A. W91-10466

## SAMPLING TECHNIQUES FOR SLUDGE, SOIL AND PLANTS.

I.N.R.A., Station d'Agronomie, Centre de Re-serches de Bordeaux, Port de la Maye, France. For primary bibliographic entry see Field 5A. W91-10468

#### 7C. Evaluation, Processing and Publication

#### MEASUREMENT AND CHARACTERIZATION OF MACROPORES BY USING AUTOCAD AND AUTOMATIC IMAGE ANALYSIS.

Iowa State Univ., Ames. Dept. of Agricultural For primary bibliographic entry see Field 2G. W91-09358

#### VISUAL INTERPRETATION OF SATELLITE IMAGERY FOR MONITORING FLOODS IN RANGI ADESH

Lakehead Univ., Thunder Bay (Ontario). Dept. of

Geography.

H. Rasid, and M. A. H. Pramanik.
Environmental Management EMNGDC, Vol. 14, No. 6, p 815-821, November/December 1990. 4 fig.

Descriptors: \*Bangladesh, \*Data interpretation, \*Flood maps, \*Flood plains, \*Floods, \*Remote sensing, \*Satellite technology, Absorption, Digital analysis, Disasters, Economic aspects, Flood forecasting, Flood plain management, History, Photography, Phinter raphy, Rivers

The physiography of Bangladesh consists primarily of alluvial floodplains. Approximately one-third of the country experiences normal annual floods. The historical floods of 1987 and 1988 were monitored by using NOAA Advanced Very High Resolution Radiometer (AVHRR) data. Digital analysis was employed for routine monitoring of the progress of flooding and flood damage assessment, progress of flooding and flood damage assessment, visual interpretation provided further estimates of flood areas for selected imagery dates. Color composites of channels I and 2 for August 18, 1987 and September 10, 15, and 24, 1988 were interpreted visually for delineating flood boundaries. On such imagery, flood areas appear in dark tones and are separated from land (light tones) by the absorption of near infrared by water and its reflectance by land and non-waterbodies. Visual interpretation was sided by the use of ground information, such land and non-waterbodies. Visual interpretation was aided by the use of ground information, such as physiographic and river maps, previous flood maps, newspaper reports, and other published and unpublished documents on the 1987 and 1988 floods. Interpreted flood areas on selected images ranged from 31% to 43% of the total area of Bangladesh. Visual interpretation overestimated flood areas by 5 to 10%, compared to the digitally analyzed data. The main advantage of visual analysis is the cost effectiveness of AVHRR photographic products, which make them more accessignation. sis is the cost effectiveness of AVHRR photo-graphic products, which make them more accessible than the digital image analysis of computer-compatible tapes. The visual analysis provides rapid assessment of overall flood situations in Ban-gladesh, which would be useful for disaster man-agement. (Brunone-PTT) W91-09368

# ESTIMATING THE NON-ADVECTIVE TIDAL EXCHANGES AND ADVECTIVE GRAVITATIONAL CIRCULATION EXCHANGES IN AN ESTUARY.

Dartmouth Coll., Hanover, NH. Dept. of Earth Sciences. For primary bibliographic entry see Field 2L.

## ERROR STRUCTURE OF MULTIPARAMETER RADAR AND SURFACE MEASUREMENTS OF RAINFALL, PART I: DIFFERENTIAL REFLEC-

Colorado State Univ., Fort Collins. Dept. of Elec-

trical Engineering.
V. Chandrasekar, and V. N. Bringi.
Journal of Atmospheric and Oceanic Technology
JAOTES, Vol. 5, p 783-795, December 1988. 8 fig. 1 tab, 28 ref, 23 append.

Descriptors: \*Data interpretation, \*Error analysis, \*Radar, \*Rainfall, \*Remote sensing, \*Statistical analysis, Comparison studies, Correlation analysis, Data acquisition, Fluctuations, Rain, Rainfall distribution, Reflectance, Simulated rainfall,

Fluctuations in the radar measurements of differential reflectivity (Z sub DR) are due to both signal power fluctuations and the cross-correlation between the horizontal and vertical polarized signals. These signals are simulated for an S-band radar for These signals are simulated for an S-band radar for backscatter from rain media, which is characterized by a gamma model of the raindrop size distribution (RSD). The parameters of the gamma RSD are then varied over the entire range found in natural rainfall. The radar simulations therefore, contain the effects of both statistical fluctuations and abusing transitions. contain the effects or both statistical fluctuations and physical variations. Sampling of raindrops as simulated using a disdrometer. Sample errors were related to the Poisson statistics of the total number of drops as a function of size. Differential reflectivity, computed from disdrometer RSD samples, was correlated with Z and other moments of the RSD, when the same disdrometer data was used. This correlation is purely statistical and is independent of any physical correlation. The radar and disdremeter simulations were then used to concern the control of the contro of any physical correlation. The radar and disdrometer simulations were then used to compare the rain rate, as derived by the radar Z sub DR-method with the rain rate estimated by the disdrometer. Results that suggest the correlation and error structure of radar/disdrometer-derived rain rates compare well with data reported in the literature. (Author's abstract)

## ERROR STRUCTURE OF MULTIPARAMETER RADAR AND SURFACE MEASUREMENTS OF RAINFALL, PART II: X-BAND ATTENU-

Colorado State Univ., Fort Collins. Dept. of Elec-

trical Engineering.
V. Chandrasekar, and V. N. Bringi. Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 5, p 796-802, December 1988. 6 fig,

Descriptors: \*Data interpretation, \*Error analysis, \*Graphical analysis, \*Radar, \*Remote sensing, \*Simulated rainfall, \*Statistical analysis, Comparison studies, Disdrometers, Fluctuations, Rainfall, Scatter plots.

Simulations of multiparameter radar observables to include X-band specific attenuation (A) were performed to study the relationship between A, Z, and differential reflectivity (Z sub DR). The triplet (A, Z, A sub DR) of measurements corresponding to specific attenuation was computed from simulaspecific attenuation was computed in simulations of disformeter raindrop spectra. These simulations include: fluctuations due to both measurement errors, and physical variations of the gamma raindrop spectra parameters. The correlation between (A/Z) and Z sub DR derived from both tween (A/Z) and Z sub DK derived from both disdrometer and radar simulations show that the disdrometer-based data yields a negative correlation (approximately 0.9) between (A/Z) and Z sub DR; for radar data the correlation is close to zero. DR; for radar data the correlation is close to zero. These correlations are due only to measurement fluctuations and not to physical variations. The large magnitude for the negative correlation compresses the scatter in plots of (A/Z) versus Zdr based on disdrometer raindrop size distribution samples; the same scatter plots using multiparameter radar data show very large scatter. When A, Z, and Z sub DR are simulated from three separate disdrometers, scatter, is more realistic and much disdrometers, scatter is more realistic and much larger than when using a single disdrometer. (Author's abstract)

## INTERACTIVE COMPUTER-AIDED DESIGN OF INVERTED SIPHONS.

California Univ., Davis. Dept. of Civil Engineer-For primary bibliographic entry see Field 8B. W91-09396

#### SIMULATION OF WIND-DISTORTED SPRIN-KLER PATTERNS.

Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering. I. Seginer, D. Nir, and R. D. von Bernuth.

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 285-306, March/April 1991. 12 fig, 2 tab, 15 ref, 3 append.

#### Evaluation, Processing and Publication—Group 7C

Descriptors: \*Irrigation design, \*Model studies, \*Sprinkler irrigation, \*Statistical analysis, \*Wind velocity, Data interpretation, Mathematical models, Simulation analysis, Spatial distribution, Sprinklers

Single-sprinkler wind-distorted distribution pat-Single-sprinkler wind-distorted distribution pat-terns are simulated utilizing drop trajectory com-putations, and compared with measured patterns. The exact formulation of the drag coefficient of single drops is not critical for applications focusing on water distribution. A drag correction factor, k, is introduced to account for the effect of the inciis introduced to account for the effect of the inci-dence angle between drag force and orientation of a jet segment. The agreement between measured and computed patterns improves considerably when the proper value of k is used. Three measures of similarity of computed to measured single patterns are put forth. The most comprehensive of these measures, denoted by sigma, is a normalized sum of squares of differences between the measured and computed local application rates. The values of k that produce the best agreement in terms of sigma seem to be an increasing function of the range of a sprinkler. Single patterns computed with the best values of k were used to calculate with the best values of k were used to calculate uniformity coefficients for a realistic spacing of the medium-pressure sprinklers under consideration. The results suggest that the computational method can be used to forecast, with an error of only a few percent, the uniformity of application under wind speeds as high as 8 m/sec. (Author's abstract) W91-09399

HYDROGRAPHIC, BIOLOGICAL AND NUTRIENT PROPERTIES OF TOMALES BAY, CALIFORNIA, MARCH 1985 TO MAY 1986. Geological Survey, Menlo Park, CA. Water Re-

sources Liv.

B. Cole, S. Hager, and J. Hollibaugh.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS

Open-File Report 90-178, 1990. 90p, 1 fig. 2 tab, 13

Descriptors: \*California, \*Data collections, \*Estuaries, \*Phytoplankton, \*Primary productivity, \*Tomales Bay, Bacteria, Hydrodynamics.

ref, 5 append.

Hydrographic, biological, and nutrient data were collected from Tomales Bay, California, between March 1985 and May 1986. Spatial distributions March 1985 and May 1986. Spatial distributions are given for salinity, temperature, chlorophyll-a, phaeopigments, light attenuation coefficients, suspended particulate matter, dissolved nutrients (nitrate, nitrate + nitrite, dissolved reactive phosphate, dissolved silica, and ammonium), total dissolved nitrogen and phosphorus, and particulate nitrogen and carbon. The data were typically collected at monthly intervals at 10 stations located along the longitudinal axis of Tomales Bay. Also reported are: (1) nutrient data for Walker and Lagunitas Creeks; (2) the results of 28 experiments measuring rates of carbon untake at selected sites measuring rates of carbon uptake at selected sites in Tomales Bay; (3) enumeration data for phytoplankton samples collected concurrently with samples for carbon uptake; (4) bacteria and blue-green algae densities; and (5) rates of bacterial uptake of thymidine at selected sites and times over the course of the study. (USGS)

POTENTIOMETRIC SURFACE OF THE IN-TERMEDIATE AQUIFER SYSTEM, WEST-CENTRAL FLORIDA, MAY 1990. Geological Survey, Tampa, FL. Water Resources

Div.

L. A. Knochenmus

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Open-File Report 90-555, 1990. 1 map (sheet), 4 fig. 5 ref. Project No. FL-002.

Descriptors: \*Florida, \*Groundwater movement, \*Maps, \*Potentiometric level, Geohydrology, Hy-\*Maps, \*Pot drogeology.

A map of the May 1990 potentiometric surface of the intermediate aquifer system in west-central Florida depicts water levels for the annual low water-level period. Hydrographs show seasonal

and annual changes that range from 0 to 30 ft or more in some years. May 1990 water levels aver-aged about 1 ft higher than May 1989 levels. Since fall 1988, the cumulative rainfall for west-central Florida is 9.6 inches below normal, resulting in drought conditions. Deficit rainfall and additional demands upon groundwater recovers. demands upon groundwater raman and administration demands upon groundwater resources for irrigation have caused large seasonal and annual water level fluctuations in most parts of the study area.

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, WEST-CEN-TRAL FLORIDA, MAY 1990.

Geological Survey, Tampa, FL. Water Resources

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Open-File Report 90-556, 1990. 1 map (sheet), 2 fig, 4 ref. Project No. FL-002.

Descriptors: \*Florida, \*Groundwater movement, \*Potentiometric level, Geohydrology, Hydrogeology, Hydrology.

The May 1990 potentiometric-surface map of the Upper Floridan aquifer in west-central Florida de-picts groundwater levels for the annual low waterpicts groundwater levels for the annual low water-level period. Water levels in wells were lower in May 1990 than in September 1989. May levels were slightly lower, 1.5 ft or less, than September levels in latitudes north of the Hillsborough-Pasco County line. In southern areas, the May levels averaged about 18 ft lower than the September averaged about 18 ft lower than the September levels. Water levels in most wells averaged 1 ft higher in May 1990 than in May 1989. Water levels declined in the northern area from May 1980 to May 1990 due to below normal rainfall. Water levels rose slightly in the southern area due to mandatory water restrictions. (USGS) W91-09488

WATER RESOURCES PUBLICATIONS FOR ALABAMA, 1857-1990, Geological Survey, Tuscaloosa, AL. Water Re-sources Div. For primary bibliographic entry see Field 10C. W91-09490

POTENTIOMETRIC SURFACE OF THE ED-WARDS-TRINITY AQUIFER SYSTEM AND CONTIGUOUS HYDRAULICALLY CONNECT-ED UNITS, WEST-CENTRAL TEXAS, WINTER 1974-75

Geological Survey, Austin, TX. Water Resources

Div. E. L. Kuniansky. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4208, 1990. 2 maps (sheets), 17 ref.

Descriptors: \*Edwards-Trinity aquifer, \*Geohydrology, \*Maps, \*Potentiometric level, \*Water table, Groundwater, Mapping.

The potentiometric surface of the Edwards-Trinity aquifer system, and Texas contiguous hydraulically connected units during the winter of 1974-75 were mapped as part of the Trinity Regional Aquifer System Analysis (RASA) project. A major goal of the Edwards-Trinity RASA project is to understand and describe the regional flow system. This map will be used in understanding groundwater movement in the aquifer. The study area extends beyond the aquifers of the Edwards-Trinity system to hydrologic boundaries, such as the Colorado River and the Rio Grande. The potentiometric surface indicates the movement of ground water toward perennial streams over the unconfined part of the system. The potentiometric surface tends to follow surface topography with hydraulic gradient of the system. The potentiometric surface tends to follow surface topography with hydraulic gradient steepest near the mountains and flattest at the center of the Edwards Plateau. The surface varies from near land surface adjacent to some streams to more than 800 feet below land surface near the mountains. (USGS)

GROUND-WATER DATA FOR THE PORT-LAND BASIN, OREGON AND WASHINGTON, Geological Survey, Portland, OR. Water Re-sources Div.

K. A. McCarthy, and D. B. Anderson

A vailable from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-126, 1990. 56p, 6 fig, 2 tab, 1 plate 3 ref.

Descriptors: \*Groundwater resources, \*Oregon, \*Washington, \*Water resources data, \*Well data, \*Well hydrographs, Springs.

Well and spring data were collected and compiled during 1986-89 as part of a study of the groundwat-er resources of the Portland Basin, Oregon and Washington. Maps show the distribution of more washington. Maps show in custrioution of more than 15,000 wells and springs within the Portland Basin, data are tabulated for 1,586 wells and 42 springs that were field located during the study, and hydrographs are included for selected wells throughout the study area. (USGS)

DIGITIZED GEOPHYSICAL LOGS FOR SE-LECTED WELLS ON OR NEAR THE IDAHO NATIONAL ENGINEERING LABORATORY.

Geological Survey, Idaho Falls, ID. Water Resources Div.

R. C. Bartholomay

R. C. Bartholomay. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-366, 1990. 347p, 6 fig, 1 tab, 3 ref. Contract No. DE-AI07-81ID12306. Project No. ID-165.

Descriptors: \*Borehole geophysics, \*Data collections, \*Data storage and retrieval, \*Geophysical methods, \*Idaho, \*Idaho National Engineering Laboratory, \*Well logs.

The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, digitized geo-physical logs from wells at the INEL (Idaho Na-tional Engineering Laboratory) logged prior to August 1989, to make them more accessible. Geo-August 1989, to make them more accession. Geo-physical logs were digitized, processed, and stored on 5-1/4 inch floppy disks. The types of geophysi-cal logs available and the number of each digitized are listed for wells on or near the INEL. Data are used for wells on or near the INEL. Data sheets with information on the wells are presented along with selected neutron, gamma-gamma, gamma, and caliper logs. (USGS) W91-09502

NATIONAL WATER SUMMARY 1987-HY-DROLOGIC EVENTS AND WATER SUPPLY

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 6D. W91-09506

WATER RESOURCES FOR ALASKA, WATER Geological Survey, Anchorage, AK. Water Re-

sources Div.

R. D. Lamke, J. L. Van Maanen, B. B. Bigelow, P.
J. Still, and R. T. Kemnitz.

Available from National Technical Information
Service, Springfield, VA 22161 as PB90-270620.

Price codes: A11 in paper copy; A04 in microfiche.

USGS Water-Data Report AK-89-1. (USGS/WRD/HD-90/286), 1990. 224p. Prepared in cooperation with the State of Alaska and with other

Descriptors: \*Alaska, \*Data collections, \*Ground-Descriptors: Anaska, Data conections, Oronno-water, Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging sta-tions, Lakes, Reservoirs, Sampling sites, Sedi-ments, Water analysis, Water level, Water temper-

Water resources data for the 1989 water year for Alaska consist of records of stage, discharge, and water quality of streams, stage of lakes, and water

#### Group 7C—Evaluation, Processing and Publication

levels and water quality of ground water wells. This volume contains records for water discharge of 85 gaging stations, water quality at 26 gaging stations, and water levels for 27 observation wells. Also included are data for 73 crest-stage partial record stations and 19 lakes. Additional water data were collected at various sites not involved in the systematic data-collection program and are pubished as miscellaneous measurements and analyses.
These data represent that part of the National
Water Data System operated by the U.S. Geological Survey and cooperating State and Federal
agencies in Alaska. (See also W90-06275) (USGS)
W91-09507

WATER RESOURCES FOR COLORADO, WATER YEAR 1988, VOLUME 2. COLORADO

Geological Survey, Lakewood, CO. Water Re-

R. C. Ugland, B. J. Cochran, R. G. Kretschman, E. A. Wilson, and J. D. Bennett. Available from National Technical Information Service, Springfield, VA 22161 as PB89-190441/ AS. Price codes: A17 in paper copy; A01 in micro-fiche. USGS Water-Data Report CO-88-2. (USGS/WRD/HD-89/229), 1989. 370p. Prepared in cooperation with the State Colorado and other

Descriptors: \*Colorado, \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Water analysis, Water level, Water temperature.

Water-resources data for Colorado for the 1988 water year consist of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report (volumes 1 and 2) contains discharge records for (Volumes 1 and 2) contains discharge records for 310 gaging stations, stage and contents of 25 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 40 crest-stage partial record stations, and 1 miscellaneous site; water record stations, and 1 miscellaneous site; water quality for 114 gaging stations, 170 miscellaneous sites; and for 14 observation wells. Four pertinent stations in bordering States also are included in this report. The records were collected and computed by the Water Resources Division of the U.S. Geological Survey. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-06306 and W90-06308) (USGS) (USGS) W91-09508

WATER RESOURCES DATA FLORIDA, WATER YEAR 1989, VOLUME 4, NORTHWEST

FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.

P. E. Meadows, J. B. Martin, and P. R. Mixson. P. E. Meadows, J. B. Martin, and F. R. Mixson. Available from National Technical Information Service, Springfield, VA 22161 as PB90-251901/AS. Price codes: Al2 in paper copy, A02 in microfiche. USGS Water-Data Report FL-89-4. (USGS/WRD/HD-90/282), 1990. 256p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: \*Data collections, \*Florida, \*Ground-water, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging sta-tions, Lakes, Reservoirs, Sampling sites, Sed-ments, Water analysis, Water level, Water temper-

Water resources data for the 1989 water year in Florida consist of daily discharge for 295 streams, periodic discharge for 36 streams, miscellaneous discharge for 75 streams, continuous or daily stage discharge for 75 streams, continuous or dauly stage for 154 streams, periodic stage for 13 streams, peak discharge for 57 streams, continuous daily tide stage for 12 sites, and peak stage for 30 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 514 wells, periodic groundwater levels for 798 wells, and miscellaneous water-level meas-

urements for 2687 wells; quality-of-water data for 149 surface-water sites and 827 wells. The data for 149 surface-water sites and 827 wells. The data for northwest Florida include continuous or daily discharge for 51 streams, periodic discharge for 3 streams, miscellaneous discharge for 41 streams, continuous or daily stage for 11 streams, peak discharge for 25 streams; continuous or daily elevations for 6 lakes, and periodic elevations for 3 lakes; continuous groundwater levels for 12 wells, and periodic groundwater levels for 140 wells, and quality of water for 20 surface water sites and 25 quality of water for 20 surface water sites and 25 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State and Federal agencies in Florida. (See W90-06338, W90-11234, W91-02627, W91-02626, and W91-02240) (USGS) W91-09509

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources

R. A. Gadoury, D. J. Kent, K. G. Ries, and H. L.

White.
Available from National Technical Information
Service, Springfield, VA 22161 as PB90-115411/
AS. Price codes: Al 2 in paper copy, A02 in microfiche. USGS Water-Data Report MA-RI-87-1.
(USGS/WRD/HD-89/278), 1989. 243p. This
report was prepared in cooperation with the States
of Massachusetts and Rhode Island and with other
agencies. agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Massachusetts, \*Rhode Island, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water-resources data for the 1987 water year for Massachusetts and Rhode Island consists of records of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 96 gaging stations, monthend contents for 30 lakes and reservoirs, water quality, for 9 for 30 lakes and reservoirs, water quality for 9 gaging stations, and water levels for 109 observation wells. Also included are data for one creststage partial-record station. Additional water data were collected at various sites, not part of the systematic data-collection program, and are pub-lished as miscellaneous measurements. A few pertinent stations in bordering states are also included in this report. These data represent that portion of in uns report. I nese data represent that portion of the National Water Data System operated by U.S. Geological Survey and cooperating State and Fed-eral agencies in Massachusetts and Rhode Island. (See also W91-06405) (USGS) W91-09510

WATER RESOURCES DATA FOR MISSISSIP-PI, WATER YEAR 1989.

Geological Survey, Jackson, MS. Water Resources

Div. E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T.

agencies.

E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T. Oakley.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-105114.
Price codes: A99 in paper copy, A99 in microfiche.
USGS Water-Data Report MS-89-1. (USGS/WRD/HF-90/281), 1990. 614p. Prepared in cooperation with the State of Mississippi and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Mississippi, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1989 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage, and water quality of lakes and reservoir; and water levels and water quality of groundwater wells. This reports contains records of water discharge at 81 gaging stations; stage records for 19 of these gaging stations; stage only at 6 gaging stations; water quality

for 24 stream flow gaging stations, 2 ungaged stream sites, 3 precipitation quality stations, and 32 wells; and water levels for 504 observation wells. Also included are peak-discharge data for 55 crest-stage partial-record stations, discharge data at 6 flood hydrograph partial-record stations and 20 low-flow partial-record stations, and water quality data at 9 partial-record or miscellaneous sites and 43 short-term study sites. Locations of these sites are shown. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represents that part of the National Water Data System operated by the United States Geological Survey and cooperating states and federal agencies in Mississippi. (See also W90-06417) (USGS) W91-09511

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1983. Geological Survey, San Juan, PR. Water Re-

R. F. Curtis, S. Guzman-Rios, and P. Diaz. R. E. Curris, S. Giuzman-Rios, and P. Diaz. Available from National Technical Information Service, Springfield, VA 22161 as PB88-149653/ AS. Price codes: A13 in paper copy; A01 in micro-fiche. USGS Water-Data Report PR-83-1. (USGS/ WRD/HD-84/027), 1984. 302p. Prepared in coop-eration with the Commonwealth of Puerto Rico, the Territors of the US Visini Page 1997. the Territory of the U.S. Virgin Islands and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Puerto Rico, \*Surface water, \*Virgin Islands (US), \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for surface-water, quality-of-water, and groundwater records for the 1983 water water, and groundwater records for the 1983 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 46 gaging stations; stage only records for three lakes; water quality for 63 streamflow or lagoon sites, 13 partial-record sites, 6 miscellaneous sites, and 10 wells, and water levels for 97 observation wells. Also included are data for 131 low-flow and 1 crest-stage partial record stations. These data represent hat part of the National Water Data System colic ted by the U.S. Geological Survey and cooperatine, local and federal agencies in Puerto Rico and the U.S. Virgin Islands. (USGS) w91-09512 W91-09512

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1984. Geological Survey, San Juan, PR. Water Resources Div.

R. E. Curtis, S. Guzman-Rios, and P. Diaz.

R. E. Curtis, S. Guzman-Rios, and P. Diaz Available from National Technical Information Service, Springfield, VA 22161 as PB88-149661/ AS. Price codes: A16 in paper copy; A01 in micro-fiche. USGS Water-Data Report PR-84-1, 1985. 374p. Prepared in cooperation with the Common-wealth of Puerto Rico, the Government of the Virgin Islands and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Puerto Rico, \*Surface water, \*Virgin Islands(US), \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for surface-water, quality-ofwater, and groundwater records for the 1984 water year for Puerto Rico and the U.S. Virgin Islands, year for ruerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 57 gaging stations; stage only records for four lakes; water quality for 63 streamflow or lagoon sites, 11 partial-record sites, and 17 wells; and water levels for 97 observation wells. Also included are data for 131 low-flow and I crest-stage partial record station. These data represent that part of the National Water Data

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System collected by the U.S. Geological Survey and cooperating local and federal agencies in Puerto Rico and the U.S. Virgin Islands. (See also W91-09512) (USGS)

WATER RESOURCES DATA SOUTH CAROLI-NA, WATER YEAR 1988. Geological Survey, Columbia, SC. Water Re-

sources Div. C. S. Bennett, R. D. Hayes, K. H. Jones, and T. W.

C. S. Bennett, K. D. Hayes, K. H. Jones, and T. W. Cooney.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-266231/
AS. Price codes: A21 in paper copy, A03 in microfiche. USGS Water-Data Report SC-88-1. (USGS-WRD/HD-89/216), 1989. 480p. Prepared in cooperation with the State of South Carolina and with

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*South Carolina, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water tempera-

Water resources data for the 1988 water year for South Carolina consist of records of stage, dis-charge, and water quality of streams, stage and contents of lakes and reservoir; and levels of groundwater wells. This volume contains records for water discharge at 104 gaging stations, stage for water discharge at 104 gaging stations, stage only at 18 gaging stations, stage and contents at 12 lakes and reservoirs, water quality at 61 gaging stations, and water levels at 43 observation wells. Also included are data for 41 crest-stage partial-record stations and discharge measurement information at 4 locations. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program. These data represent that part of the National Water Data System collected by the United States Geological Survey and cooperat-ing states and Federal agencies in South Carolina. (See also W90-06517) (USGS) W91-09514

WATER RESOURCES DATA FOR WASHING-

TON, WATER YEAR 1985. Geological Survey, Tacoma, WA. Water Resources Div.

sources Div.
E. H. McGavock, W. D. Wiggins, R. L. Blazs, P.
R. Boucher, and L. L. Reed.
Available from National Technical Information
Service, Springfield, VA 22161 as PB88-234802/
AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report WA-85-1.
(USGS/WRD/HD-87/235), 1987. 460p. Prepared
in cooperation with the State of Washington and
with other agencies. with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Washington, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, nents, Water analysis, Water temperature.

Water resources data for the 1985 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels of wells. This report contains discharge records for 196 gaging stations; stage only records records for 196 gaging stations; stage only records for 6 gaging stations; stage and contents for 41 lakes and reservoirs; water quality for 32 stream-flow-gaging stations and 12 ungaged streamsites; and water levels for 76 observation wells. Also included are data for 14 crest-stage partial-record stations and 56 partial-record or miscellaneous streamflow stations. Locations of these sites are shown. These data represent that part of the Na-tional Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Washington. (See also W90-06542) (USGS) W91-09515

WATER RESOURCES DATA FOR NEW YORK. WATER YEAR 1989, VOLUME 3. WESTERN NEW YORK.

Geological Survey, Ithaca, NY. Water Resources

J. B. Campbell, W. F. Coon, D. A. Sherwood, and

Available from National Technical Information Service, Springfield, VA 22161 as PB91-112896/ AS. Price codes: A10 in paper copy, A02 in micro-fiche. USGS Water-Data Report NY-89-3. (USGS/WRD/HD-90/302), 1990. 196p. Prepared in cooperation with the State of New York and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*New York, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling states, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of ground-water wells. This volume contains records for vater discharge at 78 gaging stations; stage only at 9 gaging stations; stage and contents at 6 gaging tations: water quality at 4 gaging stations and 9 19 gaging stations; stage and contents at 0 gaging stations; water quality at 4 gaging stations and 9 partial-record stations; and water levels at 21 ob-servation wells. Also included are data for 49 crest-stage partial record stations. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 1 and 2 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating state, local, and federal agencies in New York. (See W91-02634 and W90agencie 05264) W91-09516

WATER RESOURCES DATA FOR WISCON-SIN, WATER YEAR 1985. Geological Survey, Madison, WI. Water Re-

sources Div.

B. K. Holmstrom, P. A. Kammerer, and R. M.

Available from National Technical Information Service, Springfield, VA 22161 as PB87-172557/ AS. Price codes: A15 in paper copy, A01 in micro-fiche. USGS Water-Data Report WI-85-1. (USGS/ WRD/HD-86/249), 1986. 4149. Prepared in coop-eration with the State of Wisconsin and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, \*Wisconsin, Chemical analysis, Flow rates, Gaging stations. Lakes. Reservoirs. Sampling sites, Sedistations. stations, Lakes, Reservoirs, Sampling sites, Sedi-ments, Water analysis, Water level, Water temper-

Water-resources data for the 1985 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface and groundwater. Records of chemical analysis of precipitation, sur-Records of chemical analysis of precipitation, surface and groundwater associated with acid deposition are included. In addition water levels in observation wells are reported. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, local agencies and Federal agencies in Wisconsin. (See also W90-06266) (USGS) W91-09517

HYDROGEOLOGY AND GROUND-WATER RESOURCES OF SOMERSET COUNTY,

Geological Survey, Dover, DE. Water Resources

For primary bibliographic entry see Field 2F.

USE OF ELUTRIATE TESTS AND BOTTOM-MATERIAL ANALYSIS IN SIMULATING DREDGING EFFECTS ON WATER QUALITY OF SELECTED RIVERS AND ESTUARIES IN OREGON AND WASHINGTON, 1980-83.

Geological Survey, Portland, OR. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-09524

SIMULATION OF THE EFFECTS OF GROUND-WATER WITHDRAWAL FROM A WELL FIELD ADJACENT TO THE RIO GRANDE, SANTA FE COUNTY, NEW MEXICO.

Geological Survey, Albuquerque, NM. Water Resources Div.

For primary bibliographic entry see Field 6G. W91-09525

ARCHIVING ON-LINE DATA TO OPTICAL

Geological Survey, Reston, VA. Water Resources

J. L. Porter, J. L. Kiesler, and D. A. Stedfast. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-575, 1990. 15p, 4 fig, 5 ref.

Descriptors: \*Computers, \*Data collections, \*Data storage and retrieval, \*Optical disks, Optical data

The U.S. Geological Survey has stored instantaneous values of hydrologic data (unit values) on minicomputers since 1985. A substantial amount of disk storage is required for the on-line storage of these data. Traditionally, these data have been archived on magnetic tape to make disk storage space available for additional data. However, mag-netic tapes have a limited shelf life, and retrieval of data for a specific site is cumbersome. As the volume of unit-value data to be archived has expanded, the need for a more efficient method to store and retrieve data has increased. The Geological Survey's Distributed Information System Program Office is currently (1990) assessing optical disk storage as an alternative means of archiving unit-value data. Optical disks have a longer shelf life than magnetic tapes, and retrieval of archived data is substantially easier. The cost for data storage on write-once/read-many optical disks is comparable to that of magnetic tape and only a fraction of the cost for fixed magnetic disk (hard disk) data storage. (USGS) W91-09530

SURFACE-WATER HYDROLOGY OF HONEY LAKE VALLEY, LASSEN COUNTY, CALIFORNIA, AND WASHOE COUNTY, NEVADA.

Geological Survey, Carson City, NV. Water Resources Div.

G. L. Rockwell.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Open-File Report 90-177, 1990. 2 sheet map-report.

Descriptors: "Honey Lake, "Hydrologic maps, "Nevada, "Stream discharge, "Surface water, Annual runoff, Basins, Bathymetry, California, Lake morphology, Lassen County, Streams, Washoe County, Water quality.

Honey Lake Valley is a 2,200 sq-mi basin in north-east California and northwest Nevada about 35 miles north of Reno, Nebraska. The largest pere-nial stream in the basin is the Susan River, which nial stream in the basin is the Susan River, which drains 184 sq mi west of Susanville, California; most of the other streams are intermittent. Estimated mean annual runoff from 31 streams and 4 groups of intervening areas totals 314 cu ft/sec of which about 30% is contributed by the Susan River. The water level altitude of Honey Lake fluctuates widely, ranging from 3,977-1/2 ft above sea level when the lake is dry to a historical high level of about 4,000 ft. Stream quality is generally acceptable for most uses. Concentrations of sodium, magnesium, and calcium are about equal, and bicarbonate predominates among the anions in and bicarbonate predominates among the anions in samples from streams in the southern part of the basin; calcium, magnesium, and bicarbonate ions predominant in samples from the Susan River; and sodium and bicarbonate predominant in samples from Honey Lake. The dissolved-solids concentra-

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tion in Honey Lake varies inversely with stage as a result of evaporation. (USGS) W91-09531

FINITE-ELEMENT MODEL FOR SIMULA-TION OF TWO-DIMENSIONAL STEADY-STATE GROUNDEWATER FLOW IN CON-FINED AQUIFERS.

Geological Survey, Austin, TX. Water Resources For primary bibliographic entry see Field 2F. W91-09532

WATER-RESOURCES ACTIVITIES IN UTAH BY THE U.S. GEOLOGICAL SURVEY, OCTO-BER 1, 1988, TO SEPTEMBER 30, 1989. Geological Survey, Salt Lake City, UT. Water

Geological Survey, Salt Lake City, UT. Water Resources Div. J. S. Gates, and S. L. Dragos. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-589, 1990. 56p, 6 fig.

Descriptors: \*Data collections, \*Utah, \*Water resources data, Project planning, Projects, Water quality, Water resources studies.

Twenty-one studies of water resources in Utah were conducted by the U.S. Geological Survey from October 1, 1988 to September 30, 1989. One project began between July 1 and September 30, 1989 and four additional projects were proposed to begin on or after October 1, 1989. Twenty of the twenty-one studies were in cooperation with other twenty-one studies were in cooperation with other Federal or State, County, or local agencies. The 26 current and proposed projects include 5 involved mainly with collection of data, 2 with the hydrology of Utah's energy-resource areas, 2 on surface-water quality. 9 on groundwater transfer water quality, 9 on groundwater in unconsolidated sediments, mostly in the basins of central Utah, 1 with groundwater in consolidated rock in southern Utah, 1 with ground water quality, and 6 on ground and surface-water contamination or the potential for contamination. (USGS) W91-09540

WATER RESOURCES OF HUTCHINSON AND TURNER COUNTIES, SOUTH DAKOTA. Geological Survey, Huron, SD. Water Resources Discourage of the County of the

For primary bibliographic entry see Field 2F. W91-09543

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1990, VOLUME 1B: NORTH-EAST FLORIDA - GROUND WATER.

Geological Survey, Altamonte Springs, F Resources Div.

Resources Div.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-153213. Price codes: A16 in paper copy, A02 in microfiche. USGS Water-Data Report FL-90-1B. (USGS/WRD/HD-91/234), 1990. 354p. Prepared in cooperation with the State of Florida and other agen-

Descriptors: \*Data collections, \*Florida, \*Ground-water, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging sta-tions, Lakes, Reservoirs, Sampling sites, Sedi-ments, Water analysis, Water table, Water temper-

Water resources data for the 1990 water year in Florida consist of continuous or daily discharge for 1349 streams, periodic discharge for 40 streams; miscellaneous discharge for 75 streams, continuous or daily stage for 105 streams, continuous daily tide stage for 12 sites, periodic stage for 25 streams, peak discharge for 41 streams, and peak stage for 40 streams; continuous or daily elevations for 70 lakes, periodic elevations for 70 lakes, periodic elevations for 70 lakes; continuous groundwater levels for 441 wells, periodic groundwater levels for 1,229 wells, and miscellaneous water level measurements for 1,908 wells; quality-of-water data for 145 surface water sites and 799 wells. The data for northeast Florida include continuous or daily discharge for 164 streams, periodic discharge for 27 streams, miscellaneous discharge Water resources data for the 1990 water year in

for 22 streams, continuous or daily stage for 2 for 22 streams, continuous or daily stage for 2 streams, continuous or daily tide stage for 3 sites, periodic stage for 13 streams, peak discharge for 17 streams, and peak stage for 30 streams; continuous or daily elevation for 41 lakes, periodic elevations for 53 lakes; continuous groundwater levels for 76 wells, periodic groundwater levels for 161 wells, and miscellaneous water level measurements. and miscellaneous water level measurements for 878 wells; quality of water data for 51 surface water sites and 78 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State and Federal agencies in Florida. (See also W91-11234) (USGS) W91-09545

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources Div. R. S. Socolow, R. A. Gadoury, L. R. Ramsbey,

R. S. Socolow, R. A. Gadoury, L. R. Ramsbey, and R. W. Bell.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-153197.
Price codes: Al1 in paper copy, A02 in microfiche. USGS Water-Data Report MA-RI-89-1. (USGS/WRD/HD-90/304), 1990. 227p. Prepared in cooperation with the States of Massachusetts and Rhode Island and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Massachusetts, \*Rhode Island, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for Massachusetts and Rhode Island consist of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 91 gaging stations; monthend contents for 20 lakes and reservoirs; water quality for 9 gaging stations, and water levels for 118 observation levels. Also and water levels for 118 observation levels. Also included are data for 1 crest stage and 33 low flow partial record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. A few pertinent stations in bordering states are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (See also W91-06269) (USGS) also W91-02629) (USGS) W91-09546

WATER RESOURCES DATA FOR TENNES-SEE, WATER YEAR 1989.
Geological Survey, Nashville, TN. Water Re-

urces Div. J. F. Lowery, P. H. Counts, F. D. Edwards, and J.

W. Garrett.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-153205.
Price codes: Al 3 in paper copy, A02 in microfiche.
USGS Water-Data Report TN-89-1. (USGS/WRD/HD-90/257), 1990. 382p. Prepared in cooperation with the Tennessee Dept. of Health and Environment, Office of Water Management; the TVA and with other State, municipal and Federal

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Tennessee, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature

Water resources data for the 1989 water year for water resources data for the 1989 water year for Tennessee consist of records of stage, discharge, and water quality of streams and springs; stage, contents, and water quality of lakes and reservoirs; water levels and water quality of wells; and quantity and quality of precipitation. This report contains discharge records for 94 gaging stations; stage only records for 6 gaging stations; elevation and contents for 28 lakes and reservoirs; water quality for

19 stations and 10 wells: water levels for 32 observation wells; and 1 precipitation station. Also in-cluded are 94 crest-stage partial-record stations. Additional water data were collected at various Additional water data were collected at various stream sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Tennessee. (See also W90-06523) (USGS) W91-09547

GEOGRAPHIC INFORMATION SYSTEM DATA BASE FOR COAL AND WATER RESOURCES OF THE POWDER RIVER COAL REGION, SOUTHEASTERN MONTANA.

Geological Survey, Helena, MT. Water Resources Div.

M. R. Cannon.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-568, 1990. 83p, 27 fig, 36 tab,

Descriptors: \*Coal, \*Geographic information systems, \*Hydrologic data, \*Montana, \*Powder River Coal Region, \*Water resources data, Data collections, Databases, Mapping, Maps.

A computerized database was developed, using Geographic Information System technology, for the coal and water resources of the Powder River coal region of southeastern Montana--an area with coal reserves of about 39.7 billion tons and 1989 coal production of 37.5 million tons. The database was developed to assist agencies having responsi-bilities relating to coal evaluation, leasing, and bilities relating to coal evaluation, leasing, and management to access, display, and analyze spatial data more efficiently. The database currently contains the following 23 data themes or layers: abandoned mines, aquifers, alluvial valley floors, boundaries, climate, coal reserves and chemistry, coal stratigraphy, drainage basins, flood plains, geographic names, geology, hydrography, land survey, land use and land cover, permit sites, rail-cooldy, reads, estimated, each extraction, and sarvey, faint use a faint faint occes, permit sites, rain-roads, roads, saturated paste, streamflow, tem-plates, utilities, water quality, and wells. Each layer contains documentation consisting of an index map showing the geographic extent of coverages in the layer, coverage documentation, source-map information (where data were digitized from maps), and attribute information for the listed coverages. (USGS) W91-09557

WATER-RESOURCES INVESTIGATIONS IN TENNESSEE: PROGRAMS AND ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY, 1990-91. Geological Survey, Nashville, TN. Water Re-

F. Quinones, and B. H. Balthrop.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 91-051, 1991. 76p, 3 tab.

Descriptors: \*Flood frequency, \*Groundwater, \*Surface water, \*Suspended sediments, \*Tennessee, \*Water quality, \*Water use.

The report contains summaries of projects activities in the Tennessee District of the U.S. Geological Survey, Department of the Interior during 1990 or 1991. Each summary includes the objective of the project, the progress of results of the study to date, and the names of the cooperators and project chiefs. The activities involved hydrologic data collection investigations and information of the cooperators. logic data collection, investigations, and informa-tion dissemination. (USGS) W91-09558

#### TRANSFERRING MODELS TO USERS.

Proceedings of a symposium held November 4-8, 1990, Denver, Colorado. American Water Resources Association, Bethesda, Maryland. 1990. 404p. Edited by Eric B. Janes and William R. Hotchkiss.

#### Evaluation, Processing and Publication—Group 7C

Descriptors: \*Computer models, \*Data interpreta-tion, \*Decision making, \*Mathematical models, \*Model studies, \*Technology transfer, Computers, Expert systems, Geographic information systems, Hydrologic models, Land management, Legal as-pects, Water pollution control, Water quality, Water resources.

This proceedings volume contains 40 papers pre-This proceedings volume contains 40 papers presented at a conference on computer models in hydrological applications. The 40 papers are categorized under the following topics: geographic information systems; decision support systems; modeling I-numerical groundwater modeling; models for land management; distributing and supporting hydrologic engineering center computer programs; water quality modeling; modeling II-decision-making; and a poster session. (See W91-09571 thru W91-09610) (Korn-PTT)

TRANSFERRING A GIS WATER PLANNING MODEL TO USERS: THE WASATCH FRONT

Utah State Univ., Logan. Dept. of Civil and Envi-

oran state Univ. Logan. Dept. of Civil and Environmental Engineering.

A. B. Bishop, T. C. Hughes, H. H. Fullerton, N. E. Stauffer, and R. D. Hansen.
IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 1-11. I fig. 2 ref.

Descriptors: \*Data interpretation, \*Forecasting, \*Geographic information systems, \*Model studies, \*Planning, \*Urban planning, \*Water resources management, Aquifer systems, Computer graphics, Computer models, Computer programs, Computerized maps, Groundwater, Interactive models, Land use, Supply planning, Technology transfer, Water demand, Water importing, Water supply, Water supply development.

A combination of factors including rapid growth along the Wasatch Front region of Utah, disagree-ment over capacity of local groundwater aquifers, and political pressure from both pro-development and applications that interests concepting represent and environmental interests concerning proposed importation of water into the Salt Lake Valley have created the need for a coordinated long range urban water plan. A key part of the planning effort is the capability to make accurate water demand projections and to match demands with existing projections and to match demands with existing and possible future supplies over time. A Geographic Information System (GIS) was used to create transparent digitized land use maps and to disaggregate water demand both by type of use (various categories of homes and industries, etc.) and over space (service zones within each water within). utility). A priority goal in the development of the Wasatch Front Water Demand and Supply Planning Model (WFWDSM) was its transfer to and use by water system managers and other interested groups as a planning tool. To achieve this goal the project team emphasized both the model structure project team emphasized both the model structure is open and user participation. The model structure is open and user-friendly. Model development involved an Advisory Panel of the major water system managers and direct contact with municipalities and other smaller systems. Application of the system is now complete for Salt Lake County and is proceeding in two other counties. The software is operating in the Utah Division of Water Passacous operating in the Utah Division of Water Resources (UDWR) office and is the basis for that agency's on going planning decisions relating to meeting future needs along the Wasatch Front. (See also W91-09570) (Author's abstract)

WATER RESOURCE MANAGEMENT MODEL FOR IRRIGATION IN THE SAGINAW VALLEY, MICHIGAN.

Michigan State Univ., East Lansing. Dept. of Re-For primary bibliographic entry see Field 3F. W91-09572

FOREST MANAGEMENT NONPOINT SOURCE RISK ASSESSMENT GEOGRAPHIC INFORMATION SYSTEMS APPLICATION, National Weather Service, Tulsa, OK. River Fore-

cast Center. For primary bibliographic entry see Field 4D. W91-09573

INTEGRATED GIS/HYDROLOGIC MODEL FOR PHOSPHATE MINING RECLAMATION

University of South Florida, Tampa. Dept. of Civil Engineering and Mechanics. For primary bibliographic entry see Field 5G. W91-09574

DEVELOPMENT OF A WATER SUPPLY OP-ERATION MODEL FOR THE CITY OF NORTHGLENN, COLORADO, W. B. DeOreo, E. A. Payton, D. Kralicek, and N.

In: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 45-54. 5 fig, 2 tab, 6 ref.

Descriptors: \*Computer models, \*Decision making, \*Documentation, \*Model studies, \*Systems analysis, \*Water management, Algorithms, Computer programs, Cost analysis, Mathematical studies, Metropolitan water management, Optimization, Technology transfer, Water control, Water conveyance, Water demand.

An operations model of the City of Northglenn, CO, water supply system was developed and transferred to the City. The model is based on a network optimization algorithm which allocates flow work optimization algorithm which allocates how according to user-specified priorities. Though the algorithm is very efficient, it has certain limitations when applied to systems operated by complex agreements, exchanges, and decrees. These were hardwired into the model but with the goal of hardwired into the model but with the goal of leaving enough flexibility for later modifications to be made by City staff without additional source code programming. The model was delivered, and has been successfully used by the City to conduct a number of studies. However, working on their own, the City staff have been somewhat frustrated in their efforts to analyze scenarios using some features of the model which were designed to make it more flexible. Though there are technical solutions to these problems, a more cost-effective approach would be to invest in training and follow-up. (See also W91-09570) (Author's abstract) W91-09575

TRINIDAD RESERVOIR OPERA'
POLICY DECISION SUPPORT SYSTEM. **OPERATIONS** For primary bibliographic entry see Field 4A. W91-09576

VISUALIZATION OF WATER RESOURCE SYSTEM SIMULATION MODEL OUTPUT. Colorado Univ. at Boulder. Dept. of Civil, Envi-ronmental, and Architectural Engineering.

ronmental, and Architectural Engineering.
T. M. Over, and H. R. Horsey.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 61-71. 3 fig, 3 tab, 2 ref. U. S. Bureau of
Paclamation Agreement No. 8-FC-81-12480.

Descriptors: \*Colorado River, \*Computer models, \*Data interpretation, \*Model studies, \*Planning, \*Simulation analysis, Computer graphics, Data requirements, Decision making, Graphical analysis, Graphical methods, Simulation, Technology transfer, Water management, Water resources.

ulation models are the most important method of predicting the behavior of water resource sys-tems in current practice. They produce large amounts of high-dimensional data. Modern comamounts of high-dimensional data. Modern com-puter hardware and software potentially enable the user to display such data graphically, but how to best design such display tools is unknown. Bertin's theory of graphics provides a basis for systemati-cally examining the output information of such a model and designing display tools that illuminate the relevant information efficiently. The informa-tion consists of at least five components of varying lengths and leasts of consultation, system performlengths and levels of organization: system performance, space or system element, time, measure, and

scenario. The application of this theory to the output of a simulation model of the water and power system of the Lower Colorado River resultance in a quick enumeration of the number and type of possible graphical display tools, e.g. line graphs, scatter plots, and binary displays. This list of tools provided the basis for the development of an interactive graphical interface for the efficient and illuminating display of the output data. (See also W91-09570) (Korn-PTT)

FROM USEFUL TO REALLY USABLE: SOFT-WARE FOR WATER RESOURCES PLANNING AND MANAGEMENT.

International Inst. for Applied Systems Analysis, Laxenburg (Austria).

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 73-86. 6 fig, 6 ref.

Descriptors: \*Computer models, \*Computer programs, \*Data processing, \*Decision support systems, \*Model studies, Artificial intelligence, Computer graphics, Computers, Decision making, Geographic information systems, Graphical methods, Information systems, Interactive models, Technology transfer, User interface.

A large amount of formal, mathematical and com-putational methods have been developed in the area of water resource planning and management, and the field has a considerable history in the use of computers. However, to turn a potentially useful method into one that is actually used requires a number of special features in addition to an approach that takes psychological and institu-tional aspects as well as scientific and technical ones into account. Tools that are easy to use, equipped with a friendly user interface, use prob-lem-representation formats, and a high degree of visualization are more likely to be used. Tools that visualization are more inkely to be used. I dost that are customized for an institution and its specific view of problems, and that are developed in close collaboration with the end user, stand a better chance of being used than tools that are based on 'only' good science. Advanced information technology provides the tools to design and implement smart software, in which the emphasis is on the man-machine interface. Integration, interaction, in-telligence, visualization, and customization are key concepts that are used in the development of advanced information technology and its associated operational software. (See also W91-09570) (Author's abstract)

'EXPERT CONSULTANT': AN APPROACH FOR ENGINEERING ANALYSIS.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
M. Saleh, and J. Haestad.

Nr. Sracen, and J. Fraestad. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 87-94. 4 fig, 1 tab, 7 ref.

Descriptors: \*Artificial intelligence, \*Computer models, \*Computer programs, \*Data interpretation, \*Expert systems, \*Model studies, \*Openchannel flow, Decision making, Hydraulics, Information systems, Mathematical models, Technology transfer, Water surface profiles.

Expert system applications will have a tremendous Expert system applications will have a tremendous impact on the analysis of engineering systems. The success of a developed expert system is directly related to the strength of the knowledge embedded inside such a system. Strong knowledge will produce sharp and precise conclusions whereas weak knowledge will lead to inadequate and weak observations. The 'Expert Consultant' is a general purpose inference tool that can help a user or support engineer in handling large and complex engineering systems. Each engineering systems. engineering systems. Each engineering system should be defined in terms of analysis units. Each unit will hold a group of data which the 'Consultant' program will test against a specific knowledge base. Modifying the data of one or more of the analysis units will produce a new scenario to be

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tested by the 'Consultant' which in turn will genertested by the Consultant winch in turn will generate a new set of conclusions. The 'Expert Consultant' analysis technique is illustrated using a hydraulic system consisting of an open channel with several cross-section along its length. The 'Expert Consultant' is a practical expert system application tool which, if used appropriately, can enhance the consistent's ability in a substitute large complex probengineer's ability in analyzing large complex problems in a reduced period of time and a comanner. (See also W91-09570) (Korn-PTT) W91-09579 consistent

QUALITY ASSURANCE IN THE APPLICA-TION OF GROUNDWATER MODELS. Butler Univ., Indianapolis, IN. Holcomb Research

P. K. M. van der Heijde

P. K. M. van der Heijde. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 97-109. 2 tab, 16 ref. U. S. Environmental Protection Agency Agreement No. CR-0715363.

Descriptors: \*Computer models, \*Data interpreta-tion, \*Groundwater, \*Hydrologic models, \*Model studies, \*Quality assurance, Calibrations, Comput-er programs, Mathematical models.

Groundwater modeling is widely used to support the planning and decision-making processes in-volved in the solution of groundwater problems. Successful problem solving finds its basis in inte-grated, technically and scientifically sound data grated, technically and scientifically sound data collection, information processing, and interpretation methods. A systematic, well-defined, and controlled approach to all steps of the model application process is essential for the successful completion of a modeling project. Quality Assurance (QA) provides the framework and mechanisms to ensure that the results of the modeling study are based on the best available data and (modelingbased on the best available data and (modeling-based) analyses. A more workable description is that QA (in modeling) guarantees that the quality of the model-based analysis and advice (to decision makers) satisfies quantitative quality criteria or measures. QA can not always assure acceptable quality of the model or modeling study. However, quality of the model or modeling study. However, adequate QA can provide safeguards against faulty models or improper modeling. A model can only be invalidated when its predictions disagree with independently derived observations of real systems. Taken in a broad sense, QA provides a methodological and administrative framework to do the best possible work within the limitations of our truth and available took. current understanding of nature and available technology. (See also W91-09570) (Korn-PTT) W91-09580

CASE STUDY FOR THREE-DIMENSIONAL NUMERICAL GROUNDWATER FLOW MOD-

Weston (Roy F.), Inc., West Chester, PA. For primary bibliographic entry see Field 2F. W91-09581

NUMERICAL MODEL USES AND LIMITA-TIONS FOR GROUND WATER MANAGE-MENT.

Butler Univ., Indianapolis, IN. Holcomb Research Inst.

For primary bibliographic entry see Field 6A. W91-09582

POTENTIAL PITFALLS IN USING GROUND-

WATER MODELS.
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil Engineering.

In: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 131-140. 6 fig, 9 ref.

Descriptors: \*Computer models, \*Data interpreta-tion, \*Groundwater movement, \*Hydrologic models, \*Model studies, Data requirements, Groundwater level, Mathematical studies, Numerical modeling, Sensitivity analysis, Standards, Technology transfer

The validity of groundwater model predictions will depend on how well the model approximates

field conditions. It is essential that the model user be aware of the nature of limitations of any model simulating the physics of the groundwater system. Various issues related to misusing groundwater models include the following: (1) undue sophistication in selection of models, sometimes referred to as 'overkilling', (2) misconceptualization of the physics of the groundwater system to be represented by the model, (3) inadequacy of parameters to be used in the model, and (4) misinterpretation of the model results. There is a need for proper parametric representation of the problem and a parametric representation of the problem and a sensitivity analysis of the solution to various parameters. In addition, it is recommended that simple models be used, wherever possible, to yield a 'pilot solution' to the groundwater problem. (See also W91-09570) (Korn-PTT)

TRANSFERRING MODEL-OPERATING RE-SPONSIBILITY FROM A FEDERAL TO A STATE AGENCY.

North Carolina Dept. of Environment, Health, and

North Carolina Dept. of Environment, Fleatin, and Natural Resources, Raleigh.

J. C. Robbins, and W. L. Lyke.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 141-147. 3 fig, 10 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Interagency cooperation, \*Model studies, Calibrations, Coastal plains, Drawdown, Flow models, Groundwater management, Groundwater movement, North Carolina, Technology transfer, Water resources management.

A ground-water flow model constructed by the U.S. Geological Survey (USGS) will be utilized by the North Carolina Department of Environment, Health, and Natural Resources (EHNR) in the management of water resources (EFINN) in the management of water resources in the central Coastal Plain of North Carolina. An interim program is currently underway to transfer the use of this model from the USGS to EHNR. This program focuses on increasing the familiarity of EHNR staff with the applications and limitations of the model. Information requests are processed by EHNR, and model runs in response to these requests are planned and conducted by both agencies. Upon the complete transfer of model-operating responsibility to EHNR, EHNR will handle all information requests and model runs with limited assistance from the USGS. This will enable EHNR assistance from the CSGS. This will claim EHTM to assist local governments in effectively managing available groundwater resources. Periodic recalibration of the groundwater flow model will be performed by the USGS. The USGS and EHNR are developing a separate cooperative program to collect and summarize data needed to update the model database and perform any necessary recali-bration. (See also W91-09570) (Author's abstract) W91-09584

CRITICAL ERRORS THAT HYDROGEOLO-GIC PROFESSIONALS CAN MAKE WITH COMPUTER PROGRAMS,

Butler Univ., Indianapolis, IN. Holcomb Research

G. H. Grondin, M. Gannett, P. K. M. van der

Heijde, and R. O. Pratt.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland. 1990. p 149-158. 6 fig, 2 tab, 10 ref.

Descriptors: \*Computer models, \*Data interpreta-tion, \*Error analysis, \*Groundwater movement, \*Hydrologic models, \*Model studies, Aquifer test-ing, Computer programs, Drawdown, Geohydrology, Hydraulic conductivity, Transmissivity

Computers can aid hydrogeologic investigators in aquifer test analyses, stratigraphic analyses, groundwater flow analyses, and contaminant transport analyses. First, however, investigators must know the hydrogeologic principles and their limi-tations for each of these analyses. That knowledge and a proper conceptual understanding of the hydrogeologic system is necessary for interpreting data, results, and error review. Investigators should use computers to complement their skills, not replace them. Some investigators, however,

may overly rely on the programs for hydrogeologic analyses and interpretation. Important clues for characterizing a hydrogeologic system are not always obvious, and what may appear obviously correct may not be correct at all. Data should be analyzed thoroughly by using multiple methods of analysis. Computer analysis of data should be comanalysis. Computer analysis of data should be compared with manual analysis. Conceptual and numerical models of the hydrogeologic system should always be compared to the observed system, and the scale should always be appropriate for the investigation. Using parameter values from a general table should always be a last resort. An agree should nearly forcest that the possibility investigates should nearly forcest that the possibility. a general table should always be a last resort. An investigator should never forget that the possibility of error, misinterpretation, or oversimplification of the hydrogeologic system and oversight always exists. A hypothetical scenario which uses aquifer test data generated by the THWELLS computer resorders received with the design of the computer resorders. program, previously published distance vs draw-down analysis of data, and simulations of groundwater flow and solute transport is presented as a detailed example. (See also W91-09570) (Korn-

WEPP: MODELING FOR THE USER.

National Soil Erosion Lab., West Lafayette, IN. J. M. Laflen, and D. L. Schertz. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland.

1990. p 161-169. 1 tab, 6 ref.

Descriptors: \*Computer models, \*Erosion, \*Model studies, \*Soil erosion, Computer programs, Computers, Decision making, Hydrologic models, Interagency cooperation, Land management, Land use, Planning, Prediction, Simulation, Technology transfer, WEPP.

The Water Erosion Prediction Project is a project of several federal agencies to develop a soil erosion prediction technology that will replace the Universal Soil Loss Equation. A major contributor to the project has been the commitment by the U. S. Department of Agriculture (USDA) and other federal agencies to use the technology once developed and to participate in its development. A second major milestone was the development of a set of user requirements of the technologies capabilities, the science used, and how the technology was to be implemented. The project has been conducted by a core team of scientists and users of the technology with the users responsible for the user friendly aspects of the technology. The scientists and users have been located at a number of locations around the country and communications have been through an electronic mail system, core team ocen inrough an electronic mail system, core team meetings and component work sessions. The major criticism of the planning process was that the agency chiefs accepted a plan to which no funding was attached. Another criticism of WEPP plan-ning has been a lack of uniform support across all agencies. (See also W91-09570) (Author's abstract) agencies. (5 W91-09586

DEVELOPING PC BASED MODELS FOR GENERAL RELEASE USING A STANDARDIZED APPROACH.

Agricultural Research Service, Beltsville, MD. Hydrograph Lab.

Rydrograph Law R. T. Roberts, and R. G. Cronshey. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 171-178. 4 fig. 3 ref.

Descriptors: \*Computer models, \*Computer programs, \*Model studies, Algorithms, Data storage and retrieval, Databases, Documentation, Graphical analysis, Interactive programs, Personal computers, Technology transfer, Watershed management.

A standardized approach for implementing scientific and engineering software on IBM-compatible personal computers has evolved from a successful personal computers has evolved from a successful effort by personnel from the Soil Conservation Service (SCS) and the Agricultural Research Service to automate SCS's widely used 'Urban Hydrol-ogy for Small Watersheds', Technical Release Number 55. As a result of this effort, as well as

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several others employing the same approach, a thoroughly tested 'shell' program has been developed which manages many of the tasks inherent in computer modeling applications (e.g., data entry, data validation, file management, display of data and results). The shell software, originally written in BASICA and recently upgraded to QUICKBA-SIC 4.5, is designed to mate to application-specific program code with a minimum of code addition and modification, resulting in reliable, cost effective, PC based software. The shell software supports screen-oriented data entry, layered input data validation, utilization of many of the special use keys present on IBM-compatible keyboards, online program documentation, and includes specialized algorithms for graphics output, menu display, and pop-up windows. (See also W91-09570) (Author's abstract) W91-09587

RANGETECH: A DECISION AID FOR RANGE MANAGEMENT.

Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
J. R. Wight, K. A. Gebhardt, A. L. Huber, and C.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 179-185. 1 tab, 17 ref.

Descriptors: \*Computer models, \*Decision making, \*Expert systems, \*Model studies, \*Range management, Climatic data, Computer programs, Data processing, Databases, Forecasting, Land management, RANGETECH, Soil properties, Technology transfer, Transpiration.

A major limitation to the application of natural resource models is their complexity in terms of input requirements and output interpretations. A rangeland simulation model (RANGETECH) has been developed which uses expert system technology to ameliorate the complexity of model operation and application. Through a series of user-friendly menus and help screens, input variables and parameters are established from databases or calculated from inputs such as soil texture. Outputs are available in tabular and graphic formats to enhance interpretation. RANGETECH can be used to provide real-time simulations of soil water content, soil and plant evaporation, and growing conditions based on the ratio of actual to potential transpiration. It can also be used to forecast herbage production based on soil water content at the beginning of the growing season. (See also W91-09570) (Author's abstract)

GLEAMS MODEL—A TOOL FOR EVALUAT-ING AGRICHEMICAL GROUND-WATER LOADING AS AFFECTED BY CHEMISTRY, SOILS, CLIMATE AND MANAGEMENT. Agricultural Research Service, Tifton, GA. For primary bibliographic entry see Field 5B. W91-09589

MULTI-SPECIES RANGELAND HYDROLOG-IC MODEL: PRELIMINARY RESULTS. Agricultural Research Service, Boise, ID. Northwest Watershed Research Center. For primary bibliographic entry see Field 2A. W91-09590

ELARC: HYDROLOGIC FORECASTING FOR FLOODPLAIN MANAGEMENT WITHIN THE POTOMAC RIVER BASIN-PHASE I. National Weather Service, Harrisburg, PA. For primary bibliographic entry see Field 6F. W91-09591

TWENTY-FIVE YEARS OF DEVELOPING, DISTRIBUTING, AND SUPPORTING HYDROLOGIC ENGINEERING COMPUTER PROGRAMS.
Hydrologic Engineering Center, Davis, CA.

Hydrologic Engineering Center, Davis, CA. D. W. Davis, and V. R. Bonner. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland.

1990. p 221-227. 1 tab, 7 ref.

Descriptors: \*Computer models, \*Computer programs, \*Hydrologic models, \*Model studies, \*Training, Computers, Documentation, Software library, Software support, Technology transfer.

The Hydrologic Engineering Center performs research and provides training and technical assistance for the development, deployment, and support of hydrologic engineering methods for Corps of Engineers field office use. It was understood early that to accomplish the task successfully, it was necessary to evolve a process that would place a family of high quality computer programs in the hands of users and assure that they would be effectively used. Several single purpose programs were released in 1964 and the first major computer program releases were made in 1968. The programs were made available in source code form on punched cards, and were accompanied by user's manuals, source code compilation instructions, and test data sets. The user was offered applications training, direct phone/on-site assistance, and the opportunity to join a network of users. This same philosophy is applied today. The Center's computer program products are substantially more capale (and complicated) and are in use by a wider variety of professionals in a more diverse computer hardware and operating system environment. The service and support functions, however, are more diffused. (See also W91-09570) (Author's abstract)

DISTRIBUTION AND SUPPORT OF HEC PROGRAMS; VENDOR RESPONSIBILITIES.

Dodson and Associates, Inc., Houston, TX.

R. D. Dodson. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland.

Descriptors: \*Computer models, \*Computer programs, \*Hydrologic models, \*Model studies, Computers, Documentation, Technology transfer, Training.

Third-party vendors are playing an expanding role in the distribution and support of programs developed by the U. S. Army Corps of Engineers Hydrologic Engineering Center (HEC). Currently, many users have enough experience to make purchasing decisions based on the quality of the program documentation and technical support. The current responsibilities of HEC vendors include the following: (1) Program availability. Vendors must make the current versions of popular HEC programs widely available. (2) Technical support. Vendors must be willing and able to supply responsive and capable technical support (3) HEC error reporting: Vendors should report to the HEC any apparent problems with HEC programs. (4) Program features: Vendors should add features demanded by program users, but without making alterations in program computations. (5) Program development: Vendors may assume a role in the actual design and development of HEC programs and documentation. Initially, these activities are being carried out under contract to the HEC. (See also W91-09570) (Author's abstract) W91-09597) (Author's abstract)

HEC TECHNOLOGY TRANSFER TO USERS: THE GOOD, THE BAD, AND THE UGLY. Halff (Albert H.) Associates, Inc., Fort Worth, TX.

T. L. Lovell, and W. E. Skipwith.
IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland.
1990. p 235-240. 6 ref.

Descriptors: \*Computer models, \*Computer programs, \*Model studies, \*Technology transfer, Computers, Errors, Hydraulic models, Hydrologic models, Training, Water resources management.

The Hydrologic Engineering Center (HEC) has been the source of hydrologic, hydraulic, economic, and related water resources programs for the government, as well as for private consultants for over twenty-five years. The transfer of the HEC

developed software to the private sector has been a long, gradual process that must be considered highly successful by almost any measure of achievement. The practicing engineering community (private sector), in general, has adopted the HEC-1 and HEC-2 programs as national standards for basic hydrograph, flood routing, and backwater applications. The distribution of HEC programs has become so widespread, that it is rare to find even the smallest firms that do not include the HEC-1 or HEC-2 programs in their arsenal of engineering analysis tools. The two most significant drawbacks of this technology transfer are: (1) CR Leccart restrictions by the federal government to offer day-to-day support to non-Corps users; and (2) Lack of formal training and uniformed uses of the technology, which have created many untenable situations, such as major errors, design problems, and legal issues/lawsuits. (See also W91-09570) (Author's abstract)

USE OF AN ELECTRONIC BULLETIN BOARD SYSTEM FOR MODEL DISTRIBUTION AND SUPPORT.

Environmental Protection Agency, Athens, GA.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 243-251. 1 ref.

Descriptors: \*Bulletin board systems, \*Computer programs, \*Computers, \*Model studies, \*Technology transfer, Cost analysis, Data acquisition, Data transmission, Documentation, Information transfer, Training.

The advent of computers and telecommunications has created a high demand for the convenient access to and rapid acquisition of critical data. With its inherent efficiency and convenience, an electronic bulletin board system (BBS) offers an excellent method for the distribution and support of computer models. When compared with manual distribution, a BBS provides a considerable savings of time and money to the model developer and to the end-user. The technology offered by the BBS not only makes the models more readily available, but also makes access to personnel, expertise, and information more convenient to both staff and users. In order to meet the growing demand to support environmental risk-based decisions concerning the protection of air, water and soil, the U. S. Environmental Protection Agency established the Center for Exposure Assessment Modeling (CEAM). In September of 1988, CEAM implemented a BBS for the distribution of their CEAM-supported exposure assessment models. The CEAM BBS currently serves four main purposes: (1) downloading of CEAM supported models, (2) cuploading of user input datasets for staff review and troubleshooting assistance, (3) dissemination of current information concerning CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly between users and CEAM software, activities, and events, and (4) ability to exchange information quickly

AIDE, A SYSTEM FOR DEVELOPING INTER-ACTIVE USER INTERFACES FOR ENVIRON-MENTAL MODELS. AOUA TERRA Consultants, Decatur, GA.

AQUA TERRA Consultants, Decatur, GA.
J. L. Kittle, T. O. Barnwell, P. R. Hummel, and J.
C. Imhoff.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 253-262. 6 fig, 8 ref.

Descriptors: \*Computer models, \*Computer programs, \*Computers, \*Model studies, Databases, Technology transfer.

Recent progress in environmental science and engineering has seen increasing use of interactive interfaces for computer models. These interactive capabilities are being expanded to provide 'smarter', more flexible communication between users and the environmental models and databases they use. Software (AIDE Interaction Development

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Environment (AIDE)) has been developed to provide a straight forward, consistent methodology for designing and implementing new interactive interface systems for environmental software. AIDE combines a toolkit of utility subroutines for building individual interactive screens with instructions for developing two parallel products: a file containing all text, questions, and messages used in interactive communication, and a FORTRAN prointeractive communication, and a FOR IRAN pro-gram containing the control strategy and sequenc-ing instructions for interactions. The AIDE pack-age is based on a re-evaluation of currently avail-able tools and ideas for constructing a user inter-face. Accordingly, the manual draws on an ex-panding body of knowledge of the 'human factors' involved in effective design of man-machine interfaces. By providing a straightforward but powerful set of 'tools' and a detailed consideration of the best way to use them, the AIDE software and manual reduce the difficulty a programmer encounters in developing an interactive user inter-face. (See also W91-09570) (Author's abstract)

VERIFICATION OF WATER QUALITY MODEL CODES; NCASI EXPERIENCE WITH

MODEL CODES: NCASI EXPERIENCE WITH THE QUALZE AND WASP4 MODELS. National Council of the Paper Industry for Air and Stream Improvement, Inc., Medford, MA. R. C. Whittemore, L. C. Brown, and S. W. Hinton. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 263-271. 2 fig. 19 ref.

Descriptors: \*Computer models, \*Computer programs, \*Data processing, \*Data requirements, \*Mathematical models, \*Model studies, Calibrations, Documentation, Error analysis, Technology transfer, Uncertainty, Waste load allocation, Water

During the 1970's several mathematical model During the 19/0's several mathematical model codes were developed for general use in waste load allocation and water quality assessment. Codes used frequently in waste load allocations and Section 208 planning studies were the QUALI/QUAL-II (QUAL2) models. One element of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) surface water quality modeling program was designed to thoroughly examine and test the integrity of these model codes. The NCASI experience with model code examination has illustrated a need for model code examination has illustrated a need for the critical review of models that are extensively used in the public domain for waste load alloca-tion. Model codes should be subjected to inde-pendent peer review and scrutiny before they are released into the public domain. Secondly, the multiple options represented in the more advanced models of algal kinetics and sediment-water column interactions are generally not well understood by many modelers who use these codes. Consequently, it is important that model documentation manuals provide detailed and clear instructation manuals provide detailed and clear instruc-tions on how and when the model options should be used and the input data requirements. The need for this detail is frequently underestimated by au-thors of model user and documentation manuals. The NCASI studies of the QUAL2 and WASP4 models were designed to provide a further technimodels were designed to provide a further technical examination of important model codes and to augment published manuals. (See also W91-09570) (Korn-PTT)

STORMWATER MANAGEMENT MODEL VERSION 4.0 (SWMM 4.0)-A USER EXPERI-ENCE WITH A NEW VERSION OF A STAND-ARD HYDROLOGIC MODEL, Dames and Moore Targes EV

ARD HYDROLOGIC MODEL.
Dames and Moore, Tampa, FL.
S. J. Doyon, and S. G. Rao.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 273-278.

Descriptors: \*Computer models, \*Computer programs, \*Model studies, \*Storm water management, \*Urban hydrology, Calibrations, Documentation, Drainage patterns, Errors, Hydrologic models, Technology transfer, Uncertainty, Water quality, Watersholds

A 27 sq mi internally drained watershed in Hernando County, Florida was modeled using the Runoff and Extran Blocks of the Stormwater Management Model (SWMM) Version 4.O. The SWMM 4.O model contains many revisions and enhancements to both the Runoff and Extran blocks of the model. However, because this was a new release a period of 2-3 months was spent encountering many typical aspects of a new release: debugging, recompiling, new documenta-tion, conferring with the model authors, etc. The model was then applied to the watershed. Many problems were noted with using a newly released model, including model errors, incomplete documentation, and model limitations. Based on this case study, as well as other modeling studies, it is apparent that technology transfer deserves greater scrutiny. As sophisticated models become more routine, a greater demand is being placed on model developers and mid-level users to provide a smooth transition of these tools to end users. With a shift in end users there arises a greater chance that inexperienced engineers and scientists will in-correctly use or apply these models because they have not been properly trained, and/or model doc-umentation is poor. However with proper technol-ogy transfer, these abuses can be kept to a mini-(See also W91-09570) (Korn-PTT)

DEVELOPMENT OF A WATERSHED MAN-AGEMENT MODEL. CH2M Hill, Inc., Atlanta, GA. For primary bibliographic entry see Field 4D. W91-09599

COMPARING RISKS FROM CORN ROOTWORM INSECTICIDES IN GROUND WATER, SURFACE WATER AND AIR.
North Carolina State Univ. at Raleigh. Dept. of
Agricultural and Resource Economics. For primary bibliographic entry see Field 5B.

LOGICAL INTRANSITIVITIES AND OTHER ADMINISTRATIVE NIGHTMARES:

MODELS HELP.
Hydrosphere, Boulder, CO.
For primary bibliographic entry see Field 6E.
W91-09601

TRANSFERRING MODELS: THE CASE OF THE PHYSICAL HABITAT SIMULATION SYSTEM.
Fish and Wildlife Service, Fort Collins, CO.

Fish and windine Service, For Collins, CO.
R. T. Milhous.
IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 311-320. 2 fig. 1 tab, 9 ref.

Descriptors: \*Aquatic habitats, \*Computer models, \*Model studies, \*Technology transfer, Aquatic animals, Aquatic environment, Decision making, Documentation, Flow characteristics, Instream flow, Simulation, Training.

There are various issues associated with the transfer of an analytical system of models written for use on a computer. The Physical Habitat Simulation System (PHABSIM) was designed to simulate the physical habitat for fish and other aquatic animals. In the process of simulating the physical habitat, the physical characteristics of flow in the stream are simulated, then used to calculate the physical habitat. This is accomplished using crite-ria for aquatic animals that relates the physical characteristics of flow to the physical habitat needs characteristics of flow to the physical habitat needs of the animal. The system is interdisciplinary, requiring the knowledge of an aquatic biologist to develop habitat criteria and a hydraulic engineer or hydrologist to simulate the physical characteristics of streamflow. The thinking styles of the users have impact on the transfer process; some thinking styles require the system to be amenable to user development of alternative paths through the system; other styles require a 'best' path through the system. Experience with the transfer of PHAB-SIM to users suggests the designer of analytical computer programs should consider the following

four points; (1) Differences in user thinking styles; (2) Differences between the novice and expert user; (3) Documentation for both computer use and analytical concepts; and (4) Educating the user that he/she has the final responsibility for the application of the system. (See also W91-09570) (Author's abstract) W91-09602

### 'REQUIEM FOR LARGE-SCALE MODELS' RE-

Syracuse Univ., NY. Dept. of Civil Engineering.

IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 321-328. 18 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Model studies, Calibrations, Computers, Costs, Data requirements, Databases, Decision making, Error analysis, Errors, Technology trans-

Computer models have been useful, and maybe even indispensable to water resource engineers and analysts. However, there is much of dubious quality that has also been produced by these models. A previously published paper discussed the abuses associated with the use of large-scale models. At the center of Lee's critique were seven specific abuses allegedly committed by large-scale models, including hypercomprehensiveness, grossness, hun-griness, wrongheadedness, complicatedness, megriness, wrongheadedness, complicatedness, me-chanicalness, and expensiveness. To a greater or elsesr degree, each has some applicability to large hydrologic models such as the EPA Storm Water Management Model, the Hydrologic Simulation Program--FORTRAN, and others. To avoid these abuses it is recommended that these models be reconfigured or revised. Developers should create 'low-overhead' models that are easily managed by the typical user and directed toward identifiable the typical user and directed toward identifiable common applications. In addition, developers should continue striving to modularize their models so that errors are easily found and corrections readily made. A good model should provide a good set of tools that allow the thoughtful user to simulate a hydrologic system confidently. (See also W91-09570) (Korn-PTT)

#### LEGAL AND ECONOMIC DISINCENTIVES IN THE TRANSFER OF MODELS TO USERS, Hydrosphere, Boulder, CO.

B. L. Harding, C. M. Brendecke, and R. C. Kerr. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990, p 329-335.

Descriptors: \*Computer models, \*Computer programs, \*Computers, \*Economic aspects, \*Legal aspects, \*Model studies, Calibrations, Contracts, Decision making, Documentation, Liability, Li-censes, Technology transfer.

Contract terms which transfer ownership of turnkey engineering software from the engineer to the client create disincentives that increase the cost of the software, decrease its quality and increase the liability of the engineer for subsequent use or misuse. The practice of freely distributing software increases the liability of both the client and the increases the liability of both the client and the engineer. Software licenses are widely used in the commercial sector; their application to turnkey engineering software could benefit both parties by reducing or removing these disincentives. A properly crafted license would allow the engineer to retain ownership of intellectual property while conveying to the client the appropriate rights to use and distribute the software. License terms can be used to define how software will be distributed. be used to define how software will be distributed, to limit liability for both the client and the engineer and to specify the terms of warranty offered for the software. Retention of ownership of the software by the engineer produces economic benefits for both parties because the cost of software devel-opment can be distributed over a number of clients. Protection of intellectual property and trade se-crets allows the engineer to benefit from innovation, enhancements and testing, all of which also

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benefit the client. (See also W91-09570) (Korn-PTT) W91-09604

TO TELL THE TRUTH--HYDROLOGIC MODELS IN COURT.
Oklahoma State Univ., Stillwater. Dept. of Agri-

Okianoma State Univ., Stillwater. Dept. of Agri-cultural Engineering. C. T. Haan, J. B. Solie, and B. N. Wilson. IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 337-348. 3 fig, 2 tab, 13 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Legal aspects, \*Model studies, Calibrations, Computer programs, Decision making, Expert witness, Land use, Mathematical models, Prediction, Simulation, Technology transfer, Un-certainty, Water quality.

Increasing reliance on models to address legal questions in the area of water and water quality is almost a certainty. This will result in the law profession becoming better versed in modeling approaches and the uncertainty associated with modploatness and the uncertainty associated with modeling. Thus, expert witnesses relying on models as a basis of their testimony will increasingly have to justify not only the model, but the inputs to the model, the model assumptions, the model algorithms and interpretation of model predictions. Input estimation is one of the most difficult, and often the most frustrating expects of many model. often the most frustrating, aspects of many model-ing activities. Those using models must understand the difficulties inherent in the estimation process if the difficulties inherent in the estimation process in they are to make informed judgements about the desirability of modeling and the accuracy of model predictions. It seems clear that courts, regulatory agencies and other users of model results will press for more rigorous approaches to model validation as dependence on models becomes more common. In the future, modelers will probably have to devote more effort to validation and related error analysis if their models are to have any credibility in public or legal forums. (See also W91-09570) (Korn-PTT)

#### EXPERIENCES IN USING MODFLOW ON A

PC. K.N. Toossi Univ. of Technology, Tehran (Iran).

K. Zomorodi.
IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 351-356. 2 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Mathematical models, \*Model studies, Computer programs, Computers, Data acquisition, Data collections, Errors, Evaluation, Groundwater resources, Iran, MODFLOW, Technology transfer. Uncertainty.

As part of a groundwater resources study in west-ern Iran, mathematical modeling was used to assess the water supply potential for additional agricul-tural development in the area. The Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) was selected for use in the investigation. During the evaluation of the PC version of MODFLOW, the software was found to be a convenient and powerful modeling tool. How be a convenient and powerful modeling tool. How-ever, some troubles using various features of the software also were found. A convenient and versa-tile data input and data manipulation facility is a necessary part of a good modern hydrologic model. A comprehensive and easily readable users' manual is vital to promote convenient, proper and efficient model use. The manual must clearly list all of the model's technical assumptions, capabilities, and limitations of use. In addition, the process of transferring a model from one computer system to another must be done with careful consideration of all the hardware and architectural differences of all the hardware and architectural differences between the two systems. Complicated hardware incompatibilities may hinder the model performance on the PC. Finally, users of hydrologic models must carefully consider the quantity and quality of available field data from the early stages of the study. The model user must carefully frame the problem to the model and limit expectations from a model output. Specifically, the model scal-

ing and output expectations should be carefully matched to the information and area being considered. (See also W91-09570) (Korn-PTT)

MODEL SPATIAL VARIATION AND CORRELATION OF HYDRAULIC CONDUCTIVITY IN NATURAL MEDIA.

Delta Environmental Consultants, Inc., Tampa,

H. Ghohestani-Bojd, and W. E. Kelly.
 IN: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland.
 1990. p 357-363. 3 fig, 12 ref.

Descriptors: \*Geostatistics, \*Hydraulic conductivity, \*Model studies, \*Simulation, \*Statistical methods, Correlation analysis, Frequency analysis, Frequency distribution, Kriging, Monte Carlo method, Statistical analysis, Stochastic models, Technology

Geostatistical procedures were used to simulate spatial variation using correlation within stochastic hydraulic conductivity fields (K). In a three-dimensional flow field, using a 'second-order station-arity' assumption, hydraulic conductivity random arity assumption, nyuraunic conductary random fields were generated, using available data. The spatial structure of K was characterized by vario-grams. Then, simulated random fields and the Monte-Carlo simulation methods were used to sto-chastically simulate flow. The results were presented in the form of probability density functions (pdfs) for effective hydraulic conductivity. Next, spatial correlation was neglected and random fields were generated assuming 'stationarity'. The method then was applied to an experimental flow field. The effective hydraulic conductivity for spatially correlated and independently generated cases were compared with that of the actual field measurement values. The results reflect the effect of correlation and estimated effective hydraulic conductivity for the flow system. The overall results of the study indicate that geostatistical simulation and three-dimensional flow simulation can be combined to estimate the pdf of effective hydraulic conductivity for a layered soil system. In addition, it is shown that the effective conductivity cannot be exactly calculated. (See also W91-09570) (Korn-PTT) W91-09607

SIMULATION COMPUTER MODEL AS A BASIS FOR REVISING A PROJECT OPERAT-

Public Utility District No. 1 of Snohomish County, Everett, WA

B. F. Meaker, and R. G. Metzgar.

In: Transferring Models to Users. American Water Resources Association, Bethesda, Maryland. 1990. p 365-373. 4 fig, 1 tab, 8 ref.

Descriptors: \*Computer models, \*Model studies, \*Project planning, \*Reservoir operation, Competing use, Correlation analysis, Ecological effects, Environmental effects, Fisheries, Flood control, Flood-control storage, Hydroelectric plants, Hydroelectric power, Industrial water, Municipal water, Recreation, Simulation, Technology transfer, Water sunply. fer, Water supply.

The 112 MW Henry M. Jackson Hydroelectric Project in western Washington State's Cascade Mountains is owned by Public Utility District No. 1 of Snohomish County (District). The Federal Energy Regulatory Commission prefers that any proposed operational strategy have consensus among several agencies before granting final operating plan approval. To revise the reservoir rule curves and, therefore, the Project operating plan, the District was faced with satisfying the concerns of several regulatory agencies. The issues focused on protecting fishery resources, and providing flood control when scheduling hydroelectric power generation and meeting municipal and industrial water supply needs. A computer model was used to develop a recommended reservoir rule curve scenario that increased incidental flood storwas used to develop a recommended reservor rule curve scenario that increased incidental flood storage, energy generation, and capacity, while providing minimum instream fish flows. The consultation process using the computer model produced

information that contributed to agency support for a Jackson Project interim operating plan. (See also W91-09570) (Author's abstract) W91-09608

USER-DEVELOPER INTERACTION: THE EX-PERIENCE OF HYDROGRAPH COMBINA-TION FOR FLOOD ROUTING METHODS.

Mexican Inst. of Water Technology, Morelos.

J. Collado, and A. I. Wagner.

IN: Transferring Models to Users. American
Water Resources Association, Bethesda, Maryland.
1990. p 375-384. 2 fig. 2 tab, 10 ref.

Descriptors: \*Computer models, \*Computer programs, \*Flood routing, \*Hydrographs, \*Model studies, Data acquisition, Error analysis, Estimat-ing, Hydrograph analysis, Hydrologic models, Op-timization, Technology transfer.

Interaction between model users and model devel-Interaction between model users and model developers improves both research objectives in hydrologic model building and usefulness of such models. Interactions should occur during the development, transfer, implementation, and policy making steps associated with the model. The user's original thoughts during model development can be modified in response to the developer's suggestions. The experience of the interaction between a user and developer was illustrated in the formula. user and developer was illustrated in the formula-tion of a PC-based procedure to estimate model parameters and perform river flood routing using common methods. The developer's objective was common memors. The developer's objective was to respond to the user's needs and to optimize the whole procedure. The user was better able to decide upon capabilities and restrictions of the method being developed as the user gained knowl-edge by using the model. The result of this usereloper interaction was the identification of the need to develop a new, more robust method for parameter estimation. After a consensus of mutual obligations was reached, a procedure was devised to optimally combine several hydrographs in order to estimate the parameters for a modification of the Muskingum method of flood routing. As a result of this combination of hydrographs, the parameters contained information of more hydrograph shapes, hence better flood routing computations were possible, even when significant lateral inflows were present. (See also W91-09570) (Author's abstract) W91-09609

WATER QUALITY MODELING OF A CHAIN OF LAKES IN A RAPIDLY-DEVELOPING SUBURBAN AREA USING THE WERM MODEL.

Montgomery (James M.) Consulting Engineers, Inc., Wayzata, MN. For primary bibliographic entry see Field 5G. W91-09610

MATHEMATICAL SUBMODELS IN WATER

QUALITY SYSTEMS. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. 408p. Edited by S. E. Jorgensen and M. J. Gro-

Descriptors: \*Data interpretation, \*Environmental quality, \*Mathematical models, \*Model studies, \*Water quality, \*Water quality control, Adsorption, Aeration, Coagulation, Complex formation, Environmental protection, Growth, Heat transfer, Hydrolysis, Ion exchange, Microbial degradation, Nitrification, Oxidation-reduction potential, Photo-basical sections, Description, Predation, Pr chemical reactions, Precipitation, Predation, Primary productivity, Reaeration, Sediment-water interfaces, Sedimentation, Volatilization.

Environmental models may be divided into empirical and mechanistic models. Mechanistic models are based on quantitative descriptions of physical, chemical and biological processes in the environment. There has been an increasing demand for the development of good quantitative and ecological descriptions of these environmental processes. Such descriptions are referred to as submodels. The development of a submodel is often an important part of a total model development. The book

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presents several important chemical, physical, and biological submodels applied in water quality modbiological submodels applied in water quark mou-eling. Each chapter is devoted to one process and its related submodels. The importance of the proc-ess is discussed followed by a presentation of the most applied submodels. The chapters also discuss the parameter values and how to determine them. Among the topics included in the discussion are volatilization, reaeration, adsorption and ion exchange, and heat exchange. Sedimentation, coapulation, precipitation, complex formation, hydrolysis and chemical redox processes are also important processes which must be taken into account in the development of submodels. In addition, photochemical reactions, microbiological decomposition, and nitrification are discussed in terms of submodel development. Predator-prey submodels are also presented along with chapters on primary produc-tion and fish growth. The final chapter discusses the exchange between sediment and water and the importance of reaction rates in the consideration of mass balances. (See W91-09512 thru W91-09627) W91-09611

VOLATILIZATION.

Royal Danish School of Pharmacy, Copenhagen.

Dept. of Chemistry.
S. E. Jorgensen.
IN: Mathematical Submodels in Water Quality
Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New
York. 1989. p 19-32. 2 fig, 2 tab, 15 ref.

Descriptors: \*Mass transfer, \*Model studies, \*Multiphase flow, \*Path of pollutants, \*Volatility, \*Carbon dioxide, Chemical interactions, Chemical reactions, Equilibrium, Estimating, Eutrophication, Fugacity, Hydrogen ion concentration, Toxic wastes.

Volatilization is the transfer of components from the liquid phase to the atmosphere. Transfer procdescribing the flow from one phase to another are of major environmental interest. Submoother are of major environmental interest. Submodels of volatilization are used in many toxic substance models and in eutrophication models to account for the escape of ammonia in very eutrophic lakes with high pH during the summer. The fugacity approach has been used in environmental modeling where fugacity has the dimensions of presented and is considered at measure of second modeling where rugacity has the dimensions or pressure and is considered a measure of escaping tendency from the phase. The fugacity model may be used in four levels. The first level calculates the equilibrium distribution of a chemical between phases. Level two considers equilibrium but includes reaction and advection. The third level is desired the open control of the processing the processi devoted to a steady state, nonequilibrium situation, which implies that the fugacities are different in each phase. Level four involves a dynamic version of level three, where emissions and thus concentra-tions, are varying with time. In those cases where parameter estimation methods are necessary, i.e., for many toxic substances, the accuracy is limited for many toxic substances, the accuracy is limited by the accuracy of the estimation methods. Unfortunately, experience in the application of estimation methods is rather limited to date. However, a great deal of effort is being devoted to further developments of these methods. (See also W91-W91 (McGrn-PTT) W91-09612

REAERATION.

Institute of Meteorology and Water Management, Warsaw (Poland). M. J. Gromiec.

IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 33-64. 6 fig, 7 tab, 72 ref.

Descriptors: \*Aeration, \*Air-water interfaces, \*Model studies, \*Oxygen transfer, \*Reaeration, Absorption, Aquatic environment, Diffusivity, Dispersion, Dissolved oxygen, Estimating, Kinetics, Oxygen deficit, Oxygen uptake, Prediction.

Reaeration, the process of oxygen absorption from the atmosphere by a body of water, is one of the main sources of oxygen in aquatic systems. The reaeration process in an aquatic system is charac-

terized by its surface reaeration coefficient. The absorption of oxygen from the atmosphere by water is normally assumed to be a first-order proc-ess, i.e., the rate of absorption is directly propor-tional to the dissolved oxygen deficit. Many currently available models for the reaeration coeffi-cient are modifications of a model proposed more than fifty years ago. As a result, the reaeration coefficient is usually presented as a function of simple hydraulic parameters, such as stream velocity and depth. The reaeration coefficient may be presented as being related to molecular diffusi-vity or to a turbulent dispersion coefficient. Since different approaches have been taken to the problem, the results provided by various models differ significantly. The application of a given model outside the range of values of physical variables for which it has been developed can provide significant error. One of the main difficulties in develop-ing an adequate model for the reaeration coeffi-cient seems to be the lack of independently ob-served and accurate data for natural streams. The weakness in the prediction models for the reaera-tion coefficient is also related to the lack of well established and generally accepted means of their verification. Since atmospheric reaeration is one of the main sources of oxygen in streams the develop-ment of reliable methods for measuring and predicting the reaeration coefficient would contribute significantly to water quality modeling. (See also W91-09611) (Korn-PTT) W91-09613

ADSORPTION AND ION EXCHANGE.

Royal Danish School of Pharmacy, Copenhagen.

Royal Danish School of Fhairmacy, Copenhages. Dept. of Chemistry.
S. E. Jorgensen.
IN: Mathematical Submodels in Water Quality
Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New
York. 1989. p 65-81. 7 fig, 2 tab, 20 ref.

Descriptors: \*Adsorption, \*Ion exchange, \*Model studies, \*Water quality, Adsorption kinetics, Approximation method, Chemical interactions, Equilibrium, Estimating, Isotherms, Organic compounds, Solubility, Sorption.

Adsorption is the transfer of components from the liquid phase onto the surface of a solid phase, while ion exchange is an exchange of ions between a liquid and a solid phase. Adsorption and ion exchange are significant processes and are often included in water quality modeling. Models of pollution by surfactants, pesticides and heavy metals often include adsorption and ion exchange processes, as these materials represent easily sorbed chemicals. Consequently, good submodels for these processes are essential for the development of water quality models in general. The concentrations of pollutants in the environment are most often very low. Therefore, it is possible to apply a partition coefficient with acceptable approximations. However, adsorption isotherms and equilibtions. However, adsorption isotherms and equilib-rium constants for ion exchange are only known for a very limited number of processes of interest for environmental modeling. Therefore, estimation methods are necessary. Estimation methods for these parameters are available but much more ex-perience in the application of these methods is essential before it is possible to give a clear picture of the more general applicability of the methods. (See also W91-99611) (Korn-PTT) W91-09614

HEAT EXCHANGE.

California Univ., Davis. Dept. of Civil Engineer-

G. T. Orlob, and N. Marjanovic. IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New York. 1989. p 83-108. 5 fig, 3 tab, 10 ref.

Descriptors: "Data interpretation, "Heat flow, "Heat transfer, "Model studies, "Temperature effects, "Thermal properties, Advection, Air temperature, Air-water interfaces, Atmospheric pressure, Cloud cover, Conduction, Diffusion, Estimating, Evaporation, Humidity, Reflectance, Solar radiation, Wind.

The rate of change in heat content of a water body is determined primarily by the rates of heat trans-port into and out of the water body by the physical port mio and out of the water body by the physical processes of advection and effective diffusion and the heat exchange between the atmosphere and the water through the air-water interface. Additional exchanges of heat results from conduction between solid boundaries and the water and from biological and chemical processes, however these are usually so small relative to the primary mechanisms that they are neglected in most models. Heat exchange through the air-water interface are dependent upon the internal hydro-mechanical behavior of the mater bedu and the absolute for this transaction with water body and the physics of its interaction with the overlying air mass. Solar radiation, both short and long wave, wind, humidity, atmospheric pressure, air temperature, and cloudiness, figure pr nently in many of the physical processes involved. The processes of heat exchange are inherently complex, requiring the measurement of a variety of governing parameters. To apply equations for the net heat flux through the air-water interface, one must have available temporal measurements of at least four meteorological quantities: wind velocity, cloudiness, dry bulb air temperature, and relative humidity (or wet bulb air temperature). Additionally, one must have reasonable estimates of empiricoefficients like the Lake Hefner N, emissivity and reflectance. Alternatively, direct measurement of insolation and evaporation may reduce the uncertainties associated with empirical estimators. In certain cases an equilibrium temperature approach may be convenient for a rough estimation of heat energy transfer rates. (See also W91-09611) (Korn-

W91-09615

SEDIMENTATION.

Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry. For primary bibliographic entry see Field 2J. W91-09616

COAGULATION.

Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.

H. H. Hahn, and S. E. Jorgensen.

IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Model-ling, 14. Elsevier Science Publishing Co., New York. 1989. p 125-139. 3 fig, 6 ref.

Descriptors: \*Coagulation, \*Colloids, \*Dissolved solids, \*Model studies, \*Suspended solids, Adsorp-tion, Aggregates, Chemical interactions, Convection, Floculation, Flow characteristics, Humic acids, Inorganic compounds, Mass transfer, Mass transport, Natural waters, Organic matter, Organo-metals, Precipitation, Trace metals.

Natural waters often contain colloids, whose particles are too small for gravitational settling. The consolidation of these particles into large readily settleable aggregates is termed coagulation. It is suggested that in natural waters trace metals are present as soluble organic complexes in generally greater quantities than those present as inor-ganic ions. These complexes often interact with humic acids resulting in coagulation. The aggrega-tion of colloids is of great importance in the transport and distribution of matter in natural waters. Although dissolved substances tend to be distributed by convective mass transfer, the distribution of suspended matter is also influenced by the forces of gravity. Whether a particle will settle depends on its density, its size, and the water movement. It is not currently possible to build a workable model of coagulation processes in natural waters. However, it is possible to quantify some of the factors that influence the process. Instead, it is necessary to use observations to describe the role of coagulation in natural waters. These observations can then be natural waters. Inese observations can then be used to describe the coagulation process and its interaction with other processes. A total model, including coagulation, can then be defined in terms of changes in the influencing factors. (See also W91-09611) (Korn-PTT) W91-09617

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Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry. For primary bibliographic entry see Field 2K. W91-09618

COMPLEX FORMATION. Royal Danish School of Pharmacy, Copenhagen. Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W91-09619

HYDROLYSIS AND CHEMICAL REDOX

PROCESSES.
Royal Danish School of Pharmacy, Copenhagen.
Dept. of Chemistry. For primary bibliographic entry see Field 2K. W91-09620

PHOTOCHEMICAL REACTIONS.

Old Dominion Univ., Norfolk, VA. Inst. of Oceanography.
For primary bibliographic entry see Field 2K.
W91-09621

MICROBIAL DECOMPOSITION.

Centre d'Enseignement et de Recherche pour la Gestion des Ressources Naturelles et l'Environne-

ment, Paris (France).

B. Tassin, and D. R. Thevenot.
IN: Mathematical Submodels in Water Quality Systems. Developments in Environmental Modelling. 14. Elsevier Science Publishing Co., New York. 1989. p 217-246. 3 fig. 5 tab, 89 ref.

Descriptors: \*Biodegradation, \*Decomposition, \*Energy transfer, \*Kinetics, \*Microbial degrada-tion, \*Model studies, Aquatic environment, Bio-logical oxygen demand, Calibrations, Dissolved oxygen, Estimating, Lakes, Mass transfer, Numeri-cal analysis, Organic matter, Reservoirs, Statistical methods, Streams, Wastewater treatment.

Within aquatic ecosystems, microbial decomposition of organic matter plays a prominent role in the energy and mass transformation processes. Numerous kinetic models of water quality have been proposed to describe dissolved oxygen (DO) and biological oxygen demand (BOD) variations along streams, in lakes and reservoirs, and in wastewater treatment processes. One model states that the oxygen uptake is equal to the BOD uptake, and that both kinetics are first order. In other cases, zero-order kinetic models for DO evolution have been used. However, such models seemed to be been used. However, such models seemed to be only related to attempts to fit correctly sets of field only related to attempts to in correctly sets of field data and were not based on chemical or microbiological kinetic assumptions. It should be noted that, for very slow biodegradation processes, there is no large difference between first-order and second-order kinetics. (See also W91-09611) (Korn-PTT) W91-09622

NITRIFICATION.

Tokyo Univ. (Japan). Dept. of Urban Engineering. For primary bibliographic entry see Field 2K.

PREDATOR-PREY INTERACTIONS.

Georgia Univ., Athens. Inst. of Ecology.

October 17. Legovic.
IN: Mathematical Submodels in Water Quality
Systems. Developments in Environmental ModelSystems. Pelanics, Science Publishing Co., New ling, 14. Elsevier Science Publishing Co., New York. 1989. p 277-297. 2 tab, 47 ref. United States National Science Foundation Grants BSR-8114823 and BSR-8215587

Descriptors: \*Ecosystems, \*Food chains, \*Model studies, \*Population dynamics, \*Predation, Calibrations, Estimating, Experimental data, Growth rates, Population density, Prediction.

In models of ecological systems predator prey interactions have often been included. Literature models include from one to ten predators and even more prey populations. Although experimental

data have been included in each of the calibrated models, many parameters may better be described as being within certain (not always narrow) bounds than strictly determined. Published models tend to fit data on predators reasonably well. However, the fit is not unique in the sense that often more the fit is not unique in the sense that often more than one combination of parameters gives an equally reasonable fit. Each set of such parameters may lead to different perturbation dynamics, i.e., different perdictions. However, this is not to say that the models have no predictive value, as would be the case in an interpolation fit. Rather, calibrated and validated models are the most consistent tools available today to judge certain management alternatives. Furthermore, ecosystem models have served yet another very useful purpose, and that is o suggest modification of monitoring studies and needed laboratory experiments in order to explain better the functioning of aquatic ecosystems as a whole. (See also W91-09611) (Korn-PTT)

PRIMARY PRODUCTIVITY.
New York State Museum, Albany. Science Service

For primary bibliographic entry see Field 2H. W91-09625

FISH GROWTH.

Miljoestyrelsen, Silkeborg (Denmark). Freshwater

J. From, and G. Rasmussen.

It's Mathematical Submodels in Water Quality Systems. Developments in Environmental Modeling, 14. Elsevier Science Publishing Co., New York. 1989. p 331-369. 15 fig, 1 tab, 68 ref.

Descriptors: \*Assimilative capacity, \*Fish, \*Growth, \*Growth rates, \*Metabolism, \*Model studies, Excretion, Feeding rates, Fish physiology, Nitrogen compounds, Temperature effects,

The growth of a fish is an interaction between the fish and its environment. A growth model ought to consider all the factors that might influence growth, such as diet, fish size, and temperature; it is partly a description of the fates of food consumed. Following digestion, some of the food is assimilated through the intestinal wall while the remaining food is passed out as fecal loss. Once a meal has been ingested, the rate of metabolism mean has been ingested, the rate of metabolism increases; this is known as specific dynamic action. Energy requirements for absorption, digestion, transportation, and deposition of food materials are distinct from those for specific dynamic action, but experimentally difficult to separate. Not all of the assimilated materials can be used for physiological work or routh because some nitrogenous materials. work or growth, because some nitrogenous materials are not metabolizable but are excreted through the gills or kidneys. The remaining materials are either used for basal metabolism and activity or appear as growth. Recently, experiments were carried out to determine the parameters in match. ried out to determine the parameters in metabolic fish growth models outside aquaria. The results isin growth modes outside aquaria. The results indicated that the growth rate over 12 weeks of four brown trout was in good agreement with weights estimated on the basis of aquarium experiments. (See also W91-09611) (Korn-PTT)

SEDIMENT-WATER EXCHANGE MODELS.

Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab. L. Kamp-Nielsen

L. Kamp-Nielsen.

IN: Mathematical Submodels in Water Quality
Systems. Developments in Environmental Modelling, 14. Elsevier Science Publishing Co., New
York. 1989. p 371-398. 5 fig, 3 tab, 72 ref.

Descriptors: \*Bottom sediments, \*Geochemistry, \*Model studies, \*Particulate matter, \*Sediment-water interfaces, \*Sedimentation, Biodegradation, Bioturbation, Cycling nutrients, Deposition, Diffusion, Equilibrium, Estimating, Fate of pollutants, Hydraulic loading, Lakes, Mass transport, Metals, Mineralization, Oxidation-reduction potential, Path of pollutants, Phosphorus removal, Sediment transport Sergies port, Sorption.

Sediments consist of particulate material either brought to the water body from outside by runoff from the drainage basin, or directly by wet or dry deposition. Geologically speaking, sediments are rather young structures, but they play an important role in the global and local cycling of nutrients, organic matter, and metals. For some conservative elements the sediments can be considered almost as a permanent sink, but for other elements the sediments act only as a temporary sink which is highly integrated in the overall metabolism of the water body. Processes involved in sediment-water inter-actions can be defined as a set of submodels, each of which is confined in time and space. Each submodel serves as a linkage between compartments in the ecosystem under consideration. Essential submodels include the following: (1) An understanding of sedimentation as the transport of par-ticulate matter to the sediment from the water phase, including resuspension and horizontal transport; (2) Sorption equilibria at the sediment-water interface; and, (3) Physical, chemical, and biological processes occurring in the sediment (e.g., diffusional). sion, bioturbation, sorption equilibria, mineraliza-tion, and biological oxidation/reduction). A variecy or segment submodels with a wide span in complexity have been applied in the modeling of aquatic ecosystems. However, the selection of the appropriate complexity for sediment submodels requires a clear definition of the resolution in time and space. (See also W91-09611) (Korn-PTT) W91-09627 ty of sediment submodels with a wide span in

TWO-DIMENSIONAL NONPOINT SOURCE POLLUTION MODEL FOR SIMULATING PESTICIDE MOVEMENT TO THE WATER

Greenhorne and O'Mara, Inc., Greenbelt, MD. For primary bibliographic entry see Field 5B. W91-09652

INFLUENCE OF ACID MINE WATER IN THE DISTRIBUTION OF HEAVY METAL IN SOILS OF DONAN ANTIONAL PARK, APPLICATION OF MULTIVARIATE ANALYSIS.

Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Química Organica Gener-

For primary bibliographic entry see Field 5B.

COMPUTER PREDICTION OF MULTICOM-PONENT SORPTION WITH VARIABLE INI-TIAL CONCENTRATIONS USING A COM-PLEX MODEL.

Jordan Univ. of Science and Technology, Irbid. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-09682

EFFECT OF DOMAIN SHAPE ON PRINCIPAL COMPONENTS ANALYSES.

Oklahoma Univ., Norman. Dept. of Geography.

D. R. Legates. International Journal of Climatology IJCLEU, Vol. 11, No. 2, p 135-146, March 1991. 8 fig, 2 tab,

Descriptors: \*Climatic data. \*Climatology. Factor analysis, Principal component analysis,
Statistical methods, Air temperature, Analysis of
variance, Correlation analysis, Graphical analysis,
Mapping, Numerical analysis, Precipitation mapping, Variation coefficient

Eigenvector analyses, principal components analysis, and common factor analysis have become insis, and common factor analysis have become in-creasingly used in climatology to solve a wide variety of problems including the identification of groups of intercorrelated variables and/or stations, the reduction of the number of variables or cases under consideration, and the identification of 'causes' for the observed variation. Principal components analysis has been criticized in the past for not reflecting the spatial covariance structure ob-served in the data owing to an overdependence on the shape of the domain. This assertion has been re-examined using correlation functions and geo-

#### Field 7—RESOURCES DATA

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physically-based studies. Two examples-gage-corrected, global precipitation and global surface air temperature-were examined to illustrate that even though both fields are from the same domain, maps of the spatial distribution of the loadings on the first four principal components are highly dissimi-lar. These fields were mapped using a rectangular lar. These fields were mapped using a rectangular (cylindrical equal-area) projection and compared with other geophysically-based studies that have employed rectangularly-shaped domains as well as the rectangular domain mapping of the correlation functions. Results indicate that component loading patterns are mainly determined by the structure exhibited in the dispersion matrix and only influenced by the domain shape (through spatial auto-correlation) to a limited degree. (Author's abstract) W91-09702

DISCUSSION ON UNBIASED PLOTTING POSITIONS FOR THE GENERAL EXTREME VALUE DISTRIBUTION.

University Coll., Galway (Ireland). Dept. of Engi-

neering Hydrology.
S. L. Guo.
Journal of Hydrology JHYDA7, Vol. 121, p 33-44,
December 1990. 4 fig. 4 tab, 9 ref.

Descriptors: \*Flood data, \*Flood forecasting, \*Graphical analysis, \*Mathematical studies, \*Maximum probable floods, \*Model studies, \*Statistical models, \*Statistics, Comparison studies, Reviews.

Probability plotting positions are used for the graphical display of annual maximum flood series and serve as estimates of the probability of exceedance of those values. The unbiased plotting position formulae for the general extreme value (GEV) distribution are reviewed and compared. In order to determine which plotting position is the most suitable for GEV distribution, two experiments suitable for GEV distribution, two experiments based on the criteria for the descriptive ability and the predictive ability of the formulae were performed. The descriptive ability relates to the ability of a chosen formula to describe or fit the flood data, while the predictive ability relates to a procedure's statistical ability to achieve its assigned task, such as minimum bias and maximum efficiency of quantile estimation. The plotting formulae considuantile estimation. quantile estimation. The plotting formulae considered include: Weibull, Gringorten of Cunnane, Arnell et al. and In-na and Nguyen formulae. Ex-perimental results show that the Cunnane formula (or the Gringorten formula for the EVI distribu-tion) performs better than either the In-na or Arnell et al. formulae, both in descriptive and predictive ability. The Gringorten and Cunnane formulae are the least biased plotting position formulae for the GEV distribution. (Agostine-PTT)

UNBIASED PLOTTING POSITION FORMU-LAE FOR HISTORICAL FLOODS, University Coll., Galway (Ireland). Dept. of Engi-neering Hydrology. S. L. Guo.

Journal of Hydrology JHYDA7, Vol. 121, p 45-61, December 1990. 9 fig, 4 tab, 13 ref.

Descriptors: \*Flood data, \*Flood forecasting, \*Flood frequency, \*Graphical analysis, \*Historic floods, \*Mathematical studies, \*Statistics, Simula-

The existing plotting position formulae which consider historical floods are reviewed and compared. The plotting positions for systematic record floods below the threshold must be adjusted to reflect the below the threshold must be adjusted to reflect the additional information provided by the pre-gaging period if the historical flood data and the systematic record are to be analyzed jointly in a consistent and statistically efficient manner. However, all available formulae are unlikely to adjust these plotting positions properly. In order to determine which group of plotting position formulae are the most suitable for historical floods, two experiments based on the criteria of the descriptive ability and predictive ability and from the were performed. Five plotting position formulae are considered: Weibull, exceedance Weibull, modified exceedance Weibull, exceedance Cunnane and modified exceed. Weibull, exceedance Weibull, modified exceedance Weibull, exceedance Cunnane and modified exceedance Cunnane. It is felt that the traditional rule and exceedance rule assumptions are inconsistent with the floods over and below the threshold of perception of historical floods. A new type of formula which uses the same concept as the historically weighted moments is proposed and exam-ined. Simulation studies and numerical examples show that the new formula type performs better than the traditional Weibull rule both in descrip-tive and predictive abilities. If an unbiased plotting position formula is required, then the proposed modified exceedance Cunnane formula would be the best selection. (Author's abstract) W91-09711

ACID NEUTRALIZATION CAPACITY VARIATIONS FOR THE HAFREN FOREST STREAM, MID-WALES: INFERENCES FOR

HYDROLOGICAL PROCESSES.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W91-09713

DAILY SURFACE MOISTURE MODEL FOR LARGE SEMI-ARID LAND APPLICATION WITH LIMITED CLIMATE DATA.

National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch. For primary bibliographic entry see Field 2D. W91-09715

APPLICATION OF HYDROLOGIC MODELS TO RANGELANDS,
Texas A and M Univ., College Station. Dept. of

1exas A and M Univ., Conege Station. Dept. of Agricultural Engineering. F. Bouraoui, and M. L. Wolfe. Journal of Hydrology JHYDA7, Vol. 121, p 173-191, December 1990. 2 tab, 62 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Range management, Ecosystems, Erosion, Prediction, Reviews, Simulation analysis.

The use of hydrologic modeling and simulation in range management has been increasing. Models provide effective and efficient tools for range management and research. As management tools, they are used to make long-term predictions and to determine the responses of rangelands to manage-ment practices. As research tools, they are used to conceptualize, organize and synthesize the available information; they are also used to focus research. Several models of rangeland hydrologic processes have been used, especially for runoff, evapotranspiration and erosion. The performance of these models is reviewed and summarized. It appears, through the evaluations of the models ed on rangelands, that the methods used to simulate hydrologic processes can give a good indication of trends or average values. However, severe limitations come from the use of empirical equations that require the use of parameters that can be tions that require the use of parameters mat can be determined only through calibration or subjective judgement of the range manager. Calibration is a useful technique for helping model users obtain accurate results, but calibration can be abused by too much adjustment of the parameters. This may lead to acceptable results, but the significance of the parameters as well as the relationships expressed by the equations may be lost. The future in rangeland hydrologic modeling lies in the develop-ment of process-oriented models that include both the dynamics of the hydrologic processes and the interrelationships between the different range ecosystem components. Additional field data are re-quired for model development and validation. (Agostine-PTT) W91-09718

IDENTIFICATION OF HOMOGENEOUS RE-GIONS FOR THE PURPOSES OF REGIONALI-

Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering. For primary bibliographic entry see Field 2A. W91-09720

MODELLING CATCHMENT EVAPORATION: AN OBJECTIVE COMPARISON OF THE PENMAN AND MORTON APPROACHES, University Coll., Galway (Ireland). For primary bibliographic entry see Field 2D. W91-09722

CONCEPTUAL AND COMPUTATIONAL ASPECTS OF THE MIXING CELL METHOD TO DETERMINE GROUNDWATER RECHARGE COMPONENTS.

Botswana Univ., Gaborone. Dept. of Geology. For primary bibliographic entry see Field 2F. W91-09723

APPLICATION OF SATELLITE REMOTE SENSING TO ESTIMATE AREAL EVAPOTRANSPIRATION OVER A WATERSHED. National Board of Waters, Helsinki (Finland). For primary bibliographic entry see Field 2D. W91-09725

MODELLING HILLSLOPE WATER FLOW PATHS AND TRAVEL TIMES.

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2A. W91-09726

MATCHED DIFFUSIVITY TECHNIQUE AP-PLIED TO KINEMATIC CASCADES: I. MODEL DESCRIPTION AND VALIDATION. Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.
For primary bibliographic entry see Field 2E.

MATCHED DIFFUSIVITY TECHNIQUE AP-PLIED TO KINEMATIC CASCADES; II. ANAL-YSIS OF MODEL PERFORMANCE.

Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft. B. H. Schmid.

Journal of Hydrology JHYDA7, Vol. 121, p 363-377, December 1990. 10 fig,1 tab, 5 ref.

Descriptors: \*Diffusivity, \*Flood routing, \*Kinematic cascades, \*Model studies, \*Model testing, \*Overland flow, \*Routing, Laminar flow, Simulation analysis, Turbulent flow.

Performance of the Muskingum-Cunge (MC) method for overland flow was investigated by comparing numerical results with semi-analytical solutions. Special attention is paid to cases involving discontinuous solutions. A large number of simulations was carried out to make a full comparison between semi-analytical and MC-based computations of timematic Now on a two-plane cascade. tations of kinematic flow on a two-plane cascade. In the course of this investigation, MC routing was shown to produce perfectly satisfactory results for turbulent flow cases, both with and without rea-sonably strong shocks. It was found necessary, however, to decrease space and time increments as shock strength increased. Favorable results were also obtained for laminar flow without shocks. Shock-affected laminar kinematic flow, however, proved to be outside the range of applicability of the MC model. (See also W91-09727) (Agostine-PTT) W91-09728

ESTIMATION OF NATURAL GROUNDWATER RECHARGE IN THE KAROO AQUIFERS

OF SOUTH AFRICA.
Orange Free State Univ., Bloemfontein (South Africa). Inst. for Groundwater Studies. For primary bibliographic entry see Field 2F. W91-09730

COMPARISON OF SHORT-TERM MEASURE-MENTS OF LAKE EVAPORATION USING EDDY CORRELATION AND ENERGY BUDGET METHODS,

Geological Survey, Denver, CO. For primary bibliographic entry see Field 2D. W91-09732

#### Evaluation, Processing and Publication—Group 7C

MODELING DAILY RAINFALL USING A SEMI-MARKOV REPRESENTATION OF CIR-CULATION PATTERN OCCURRENCE, Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydrologie und Wasserwirtschaft.

For primary bibliographic entry see Field 2B. W91-09734

GASEOUS DIFFUSION OF CO2 IN THE UN-SATURATED ZONE,
Technical Univ. of Denmark, Lyngby. Fysik-

For primary bibliographic entry see Field 2K. W91-09736

EVALUATION OF PROCEDURES TO ESTI-MATE MONTHLY PRECIPITATION PROB-

MATE MONTHLY PRECIPITATION PROBABILITIES,
Oklahoma Univ., Norman. Dept. of Geography.
For primary bibliographic entry see Field 2B.
W91-09740

COMPARATIVE ANALYSIS OF SEVERAL CONCEPTUAL RAINFALL-RUNOFF MODELS

Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche

For primary bibliographic entry see Field 2E.
W91-09742

HYDROGRAPH SEPARATION: A COMPARISON OF GEOCHEMICAL AND ISOTOPE TRACERS.

Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program. For primary bibliographic entry see Field 2E. W91-09745

FINITE-ELEMENT METHOD FOR THE SOLU-TION OF THE SAINT VENANT EQUATIONS IN AN OPEN CHANNEL NETWORK. Gdansk Technical Univ. (Poland). Inst. of Hyrdo-

R. Szymkiewicz. Journal of Hydrology JHYDA7, Vol. 122, p 275-287, January 1991, 8 fig. 11 ref.

Descriptors: \*Finite element method, \*Model studies, \*Open channels, \*Open-channel flow, \*St Venant equation, Flow channels, Hydrology, Mathematical studies, Unsteady flow.

The finite-element method is often used for the solution of complicated partial differential equasolution of complicated partial differential equa-tions. The method is especially effective for two and three-dimensional (2-D, 3-D) problems. Its ap-plication to one-dimensional (1-D) problems is usu-ally considered to be unsuitable. However, using the finite-element method for the Saint Venant equality effective as the best known difference schemes. The method is applied to the solution of the Saint Venant equations. Use of the method eliminates oscillations of the type '2 delta x', thus assuring a smooth and stable solution. An example from a real water channel network is analyzed and assuring a smooth and stable solution. An example from a real water channel network is analyzed and the results obtained are compared with observations. The results show that the finite-element method is an effective tool in the solution of unsteady flows in open channels. The proposed solution algorithm is clear and simple. It appears that the finite-element method can be successfully applied for practical problems as an alternative to the well-known difference solvense. (Author's absolute of the property of the propert well-known difference schemes. (Author's abstract) W91-09746

BIAS ERROR IN MAXIMUM LIKELIHOOD ESTIMATION.

Exxon Production Research Co., Houston, TX. Offshore Div.

Orlsand St. P. Koch.
Journal of Hydrology JHYDA7, Vol. 122, p 289-300, January 1991. 5 fig, 3 tab, 20 ref.

Descriptors: \*Error analysis, \*Hydrologic data, \*Mathematical studies, \*Maximum likelihood esti-

mation, \*Oceanography, \*Statistical methods, \*Statistics, Bias error, Fatigue, Floods, Strength, Wave height.

Gumbel's extreme value distributions are frequently used in the study of oceanographic and hydrologic data. In addition, the Frechet and Weibull distributions are used in such areas as fatigue and ultimate strength analysis. A study of bias error in the maximum likelihood estimates of parameters for the Gumbel, Frechet, and Weibull distributions is documented. The study suggests that a single polynomial expression can be used to correct the bias error of all three distributions. The expression is used to develop an error function for each distribution. The error function allows study of the impact of corrections for his error on extreme Gumbel's extreme value distributions are frequentimpact of corrections for bias error on extreme value predictions for reasonable values of the dis-tributional parameters. Thoroughly documented studies by other investigators have shown the maximum likelihood estimation method to be an efficient method of estimating distributional parameters. The results of this study provide a polynomial expression to correct for bias error which can be al expression to correct for bias error which can be used for all three members of the Gumbel family of extreme value distributions. The expression can generally be resolved with the results of previous investigators. The documented results also lead to the conclusion that the influence of correcting for maximum likelihood estimation bias error is small, and probably insignificant, for most applications in which the Gumbel extreme value distribution family is being used. (Agostine-PTT) W91-09747

ANALYSIS OF FLOW INTO DRAINTILE IN THREE-DIMENSIONAL FLOW FIELD, Lakehead Univ., Thunder Bay (Ontario). Dept. of

Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-09750

COMPARISON OF INDEX-SEQUENTIAL AND AR(1) GENERATED HYDROLOGICAL SEQUENCES.

Loyola Marymount Univ., Los Angeles, CA. Dept. of Civil Engineering. For primary bibliographic entry see Field 2A. W91-09751

DETERMINATION IN REAL TIME OF THE RELIABILITY OF RADAR RAINFALL FORE-Ecole Nationale des Ponts et Chaussees, Paris

For primary bibliographic entry see Field 2B. W91-09752

SOIL-MOISTURE CONDITIONS AND DIS-CHARGE FORECASTING (ETAT HYDRIQUE DU SOL ET PREVISION DES DEBITS).

Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique. For primary bibliographic entry see Field 2A. W91-0976.

ESTIMATION OF VARIABLES AT UNGAGED LOCATIONS BY EMPIRICAL ORTHOGONAL FUNCTIONS,

Indian Inst. of Science, Bangalore. Dept. of Civil For primary bibliographic entry see Field 2E. W91-09780

MAGNITUDE AND FREQUENCY OF DEBRIS Maryland Univ., College Park. Dept. of Civil En-

For primary bibliographic entry see Field 2J.

MESO-BETA SCALE POTENTIAL VORTICITY ANOMALIES AND RAINBANDS: PART II. MOIST MODEL SIMULATIONS.

Toronto Univ. (Ontario). Dept. of Physics. For primary bibliographic entry see Field 2B.

W91-09790

TWO-DIMENSIONAL UNSATURATED FLOW IN IRREGULARLY SHAPED REGIONS USING A FINITE VOLUME METHOD.

National Technical Univ., Athens (Greece). Lab.

For primary bibliographic entry see Field 2G. W91-09793

RETRIEVAL OF MONTHLY RAINFALL INDI-CES FROM MICROWAVE RADIOMETRIC MEASUREMENTS USING PROBABILITY DIS-TRIBUTION FUNCTIONS.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2B. W91-09800

GROUND-WATER PUMPAGE FROM THE GULF COAST AQUIFER SYSTEMS, 1960-85, SOUTH-CENTRAL UNITED STATES.

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 2F. W91-09816

WATER-LEVEL MAPS OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1987.

Geological Survey, Little Rock, AR. Water Resources Div.

P. W. Westerfield. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4089, 1990. I map (sheet) 6 fig., 16 ref.

Descriptors: \*Arkansas, \*Maps, \*Mississippi River Valley alluvial aquif, \*Potentiometric level, \*Water level, Arkansas County, Cross County, Hydraulic gradient, Hydrologic maps, Mississippi Alluvial Plain, Poinsett County.

Water level maps for the Mississippi River Valley alluvial aquifer, which consists of sand and gravel in flood-plain and terrace deposits of Quaternary age and supplies much of the water used for irrigation and aquaculture in eastern Arkansas, are presented for spring and fall 1987 in a map report. The maps of the potentiometric surface, water-level change, and depth to water illustrate the effects of large withdrawals for irrigation on water levels in the aquifer. Two large areas of depression in the potentiometric surface, caused by large withdrawals of ground water for irrigation, occur in Arkansals of ground water for irrigation of the ground water for ir potentiometric surface, caused by large withfuraw-als of ground water for irrigation, occur in Arkan-sas, Lonoke, Prairie, Cross, and Poinsett Counties. The report was prepared by the U.S. Geological Survey in cooperation with the Arkansas Geologi-cal Commission, the Arkansas Soil and Water Conservation Commission, local conservation districts, and the U.S. Soil Conservation Service. (USGS) W91-09818

HYDROGEOLOGIC UNIT MAP OF THE PIED-MONT AND BLUE RIDGE PROVINCES OF NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.

Div. C. C. Daniel, and R. A. Payne.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4035, 1990. 1 map (sheet) scale 1:500,000, 2 fig, 1 tab, 20 certifications. ref.

Descriptors: \*Geohydrology, \*Hydrogeologic units, \*Maps, \*North Carolina, \*Well yield, Blue Ridge province, Igneous rocks, Piedmont province, Sedimentary rocks.

The numerous geologic formations and rock types in the Piedmont and Blue Ridge provinces of North Carolina have been grouped into 21 hydrogeologic units on the basis of their water-bearing potential as determined from rock origin, composition, and texture. All major classes of rocks—meta-

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morphic, igneous, and sedimentary—are present, although metamorphic rocks are the most abundant. The origin of the hydrogeologic units is indicated by the rock class or subclass (metaigneous, metavolanic, or metasedimentary). The neous, metavolanic, or metasedimentary). The composition of the igneous, metaigneous, and metavolcanic rocks is designated as felsic, intermediate, or mafic except for the addition in the metavolcanic group of epiclastic rocks and compositionally undifferentiated rocks. Composition is the controlling attribute in the classification of the metasedimentary units of gneiss (mafic or felsic), marble, and quartzite. The other metasediments are designated primarily on the basis of texture (grain size, degree of metamorphism, and development of foliation). Sedimentary rocks occur in the Piedmont in several downfaulted basins. A computerized data file containing records from more than 6.200 wells was analyzed to determine average o,200 wells was analyzed to determine average well yields in each of the 21 units. The well yields were adjusted to an average well depth of 154 ft and an average diameter of 6 inches, the average of all wells in the data set, to remove the variation in an wells in the casa set, to remove the variation in well yield attributed to differences in depth and diameter. Average yields range from a high of 23.6 gallons per minute for schist to a low 11.6 gallons per minute for sedimentary rocks of Triassic age. (USGS)

CLIMATE AND STREAMFLOW VARIABILITY RELATED TO WATER SUPPLY IN THE WESTERN UNITED STATES.

Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.

For primary bibliographic entry see Field 2B. W91-09824

ARCHIVING OF DEEP PERCOLATION MODELS, DATA FILES, AND CALCULATED RECHARGE ESTIMATES FOR THE COLUMBIA PLATEAU REGIONAL AQUIFER ATEAU REGIONAL AQUIFER WASHINGTON, OREGON, AND SYSTEM, IDAHO.

Geologic cal Survey, Tacoma, WA. Water Re-

For primary bibliographic entry see Field 2F. W91-09828

SUMMARY OF WATER-RESOURCES ACTIVI-TIES OF THE U.S. GEOLOGICAL SURVEY IN WASHINGTON: FISCAL YEAR 1989.
Geological Survey, Tacoma, WA. Water Re-

sources Div.

Sources Div.

J. A. Wayenberg.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS

Open-File Report 90-180, 1990. 89p, 1 pl, 1 tab.

Descriptors: \*Data collections, \*Groundwater, \*Surface water, \*Washington, \*Water resources data, Water quality.

The water-resources-related activities of the U.S. Geological Survey in the State of Washington are described for the 1989 fiscal year (October 1, 1988, to September 30, 1989). These activities consist of collecting water resources data and conducting interpretive hydrologic investigations and re-search. The water resources data and the results of search. The water resources data and the results of the interpretive investigations and research are published or released by the U.S. Geological Survey or by cooperating agencies. The report includes a bibliography of U.S. Geological Survey hydrologic publications for Washington and infor-mation on how to obtain copies. (USGS) W91-09829

RESULTS OF TEST DRILLING AND HYDRO-LOGIC MONITORING IN THE INDIAN BATHTUB AREA, OWYHEE COUNTY, SOUTHWESTERN IDAHO, JANUARY 1989 THROUGH SEPTEMBER 1990. Geological Survey, Boise, ID. Water Resources

Div.

H. W. Young, M. L. Jones, D. J. Parliman, and A.

M. Tungate. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Open-File Report 90-597, 1990. 40p, 4 fig, 2 tab, 1 ref. USGS Project No. ID172.

Descriptors: \*Borehole geophysics, \*Data collections, \*Geohydrology, \*Groundwater data, \*Hot springs, \*Idaho, \*Indian Bathtub Spring, \*Thermal water, \*Water resources data, Chemistry, Isotopes, Test holes, Well data, Well hydrographs

Groundwater data were collected in the Indian Bathtub Area, 60 mi southeast of Boise in south-western Idaho. The area comprises about 120 sq mi of valleys and uplands in the lower Bruneau River, Sugar Creek, Big Jacks Creek, and Little Valley Creek drainage basins in northern Owyhee County. During the period March 17 through May 16, 1990, eight test holes were drilled and complet-10, 1990, eight test noise were drilled and completed at four sites. After completion, six test holes were equipped with continuous water level recorders. Water samples were collected from the six holes for chemical and isotopic analyses. During the period January 1989 through September 1990, water levels in selected thermal-water wells and dispharace at selected excitors water water wells and discharges at selected springs were measured. These data were collected as part of a 3 1/2 year study to determine the cause or causes of decreased discharge at Indian Bathtub Spring and other thermal springs along Hot Creek. (USGS) W91-09830

BIBLIOGRAPHY OF SELECTED WATER-RE-SOURCES PUBLICATIONS ON NEVADA BY THE U.S. GEOLOGICAL SURVEY, 1885 THROUGH 1990.

Geological Survey, Carson City, NV. Water Resources Div

Sources Div.

R. L. Bunch.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Open-File Report 90-595, 1991. 41p, 1 fig. 493 ref.

Descriptors: \*Bibliographies, \*Nevada, \*Water resources, Publications, Groundwater, Hydrology, Surface water, Technical writing.

References to 493 water resources publications on References to 493 water resources publications on Nevada are listed alphaetically by senior author. Most of the publications were written during 1962-90 by scientists and engineers of the Nevada Dis-trict, which is part of the Water Resources Divi-sion, U.S. Geological Survey. Also included, for historical perspective, are selected earlier reports by Water Resources Division authors that deal with Nevada hydrology. The references include several type of Geological Survey book and map publications, as well as State-series reports, journal articles, abstracts, and graduate-degree theses. (USGS) W91-09836

STORM-TIDE ELEVATIONS PRODUCED BY HURRICANE HUGO ALONG THE SOUTH CAROLINA COAST, SEPTEMBER 21-22, 1989. Geological Survey, Columbia, SC. Water Resources Div. For primary bibliographic entry see Field 2E. W91-09841

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1990, VOLUME 2. GROUND WATER AND GROUND-WATER QUALITY

Geological Survey, Richmond, VA. Water Resources Div.

sources Div.
B. J. Prugh, and F. J. Easton.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-176131.
Price codes: Al7 in paper copy, A03 in microfiche.
USGS Water-Data Report VA-90-2. (USGS/WRD/HD-91/236), 1991. 389p. Prepared in cooperation with the State of Virginia and with other

Descriptors: \*Virginia, \*Hydrologic data,
\*Groundwater, \*Data collections, \*Water quality, Chemical analysis, Water temperature, Sampling sites, Water analysis, Water level.

Water resources data for the 1990 water year for Virginia consist of records of water levels and

water quality of groundwater wells. This report (Volume 2. Ground Water and Ground-Water Quality Records) contains water levels at 348 observation wells and water quality at 98 wells. Locations of these wells are shown. The data in this report represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (See also W90-06541) (USGS) W91-09864

WATER RESOURCES DATA FOR MINNESO-TA, WATER YEAR 1989, VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN. Geological Survey, St. Paul, MN. Water Resources Div.

K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-161174. Price codes: Al5 in paper copy, A02 in microfiche. USGS Water-Data Report MN-89-2. (USGS/WRD/HD-91/233), 1990. 335p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: \*Minnesota, \*Hydrologic data, \*Groundwater, \*Surface water, \*Data collections, \*Water quality, Lakes, Reservoirs, Chemical analysis, Water temperature, Sampling sites, Water analysis, Precipitation, Data collections, Sediments, Flow rates, Gaging stations.

Water resources data for the 1989 water year for Minnesota consist of records of stage, discharge and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 57 gaging stations; stage and contents for 9 lakes and reserstations, stage and contents for 9 lacks and reservoirs; water quality for 13 stream stations; 1 partial-record stream station, 11 partial-record lake stations, 21 miscellaneous sites, 1 precipitation station, and 143 wells; and water levels for 129 observing the station of t vation wells. Also included are 65 high flow partial record stations and 93 low flow partial record stations. Additional water data were collected at various sites, not part of the systematic data collec-tion program and are published as miscellaneous measurements or low-flow investigations. These data, together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-07845) (USGS)

INFORMATIONAL NEEDS FOR LOCAL GROUNDWATER MANAGEMENT DECI-

Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection. For primary bibliographic entry see Field 4B. W91-09877

GIS-BASED APPROACH TO EVALUATING REGIONAL GROUNDWATER POLLUTION POTENTIAL WITH DRASTIC.

Geo Decisions, Inc., P.O. Box 1028, Lemont, Pennsylvania 16851. B. M. Evans, and W. L. Myers.

Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 242-245, 1990. 7 ref.

Descriptors: \*DRASTIC system, \*Geographic information systems, \*Groundwater pollution, \*Model studies, \*Risk assessment, Computer models, Databases, Delaware, Hydrologic data, Hydrologic maps, Regional analysis, Water pollution meagement.

A geographic information system (GIS)-based approach to regional groundwater pollution modeling was developed using DRASTIC, a relative rating system. This methodology relies on the use of commonly available large-area groundwater re-lated data for evaluating groundwater pollution potential in regional areas larger than 50 square miles. This study consisted of two primary compo-

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nents: (1) the creation of a multilayered geographic data base for a 100-square-mile area in southeastern Delaware and (2) predictive modeling that resulted in the creation groundwater pollution 'risk' and 'hazard' assessment maps for the study area. The regional perspective and parcel-size data resolution afforded by a GIS appear to be compatible with information requirements of various planning and regulatory activities conducted by governmental agencies. Although GIS was initially designed for assessing regional groundwater quality, the geographic data base can be expanded easily to encompass other applications ranging from urban planning and land appraisal to soil erosion and nonpoint pollution source evaluation. (Feder-PTT) W91-09882

GEOGRAPHIC INFORMATION SYSTEM FOR GROUNDWATER PROTECTION PLANNING, Rhode Island Univ., Kingston. Dept. of Natural Persystems Sciences.

Riode Island Cirth, Kingston, Dept. of Natural Resources Science. C. P. Baker, and E. C. Panciera. Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 246-248, 1990. 8 ref.

Descriptors: \*Geographic information systems, \*Groundwater, \*Groundwater protection planning, \*Hydrologic maps, \*Management planning, \*Water pollution control, Databases, Hydrologic data, Interagency cooperation, Public participation, Rhode Island, Water policy.

The Rhode Island GIS (RIGIS) is a statewide natural resource data base that focuses on the development of a statewide groundwater classification map. RIGIS was established in 1985 and renewed in 1987 under a cooperative agreement between the Rhode Island Department of Environmental Management and the University of Rhode Island. Since 1987, increasing numbers of individuals and state institutions have used and contributed to RIGIS. Prior to the start of the GIS program, much of the available groundwater data were mapped at different scales, stored in different locations and inefficiently organized. Manual maps and overlays were time-consuming and cumbersome, and tabular data, such as information on potential pollution sources, often lacked accurate geographic locations. With the input of many important groundwater data layers in the GIS, a central database now exists. Efficient production of overlays, spatial data analyses and cartographic products tailored to individual user needs are now possible. (Feder-PTT)

POPULATION ECOLOGY OF A PELAGIC FISH, XENOMELANIRIS VENEZUELAE (ATHERINIDAE), IN LAKE VALENCIA, VENEZUELA.

(ATHERINIDAE), IN LARE VALENCIA, VENEZUELA.
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.
For primary bibliographic entry see Field 2H.
W91-09916

TRANSPORT MODELLING IN WATERSHEDS. Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides. B. Caussade, and M. Prat.

Ecological Modelling ECMODT, Vol. 52, No. 3/ 4, p 135-179, December 1990. 16 fig, 4 tab, 66 ref, append.

Descriptors: \*Environmental effects, \*Hydrologic models, \*Mathematical models, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutants, \*Water pollution sources, Data interpretation, Economic aspects, Ecosystems, Soil physical properties, Watersheds.

At the watershed level two kinds of pollution occur: (1) easily localized, point pollution, either of agricultural, urban, or industrial origin, whose control does not usually present any problems apart from financial ones; and (2) nonpoint pollution, which is widespread throughout the environment, and its effects can only be calculated in the long-term, and generally leads to an examination of fundamental problems at the level of the ecosystem involved. A watershed model should describe, as

realistically as possible: the effects on the environment concerned; transport and transformation of products likely to contribute to its degradation; and other contributing factors. There are two possible explanations to describe the transfer of water into the soil: (1) consideration of the soil as a rigid solid complex which includes pores (voids) which may interconnect; and (2) consideration of the soil as a set of closely interwoven continuous environments. It is expected that local research will aid in the understanding of the phenomena and modeling processes. Integration of biological processes into the model allows a better overall comprehension of the minimal information available in order to obtain a correct study of the ecosystem. The model must be adapted to the spatiotemporal scale of investigation. Models of nutrient transfers must be improved at the watershed scale. Integration of equations of the physical type of the soil and the concept of spatial variability adds to the amount of information available and necessary for the development of models. (Brunone-PTT)

REGULATION OF THE SOIL WATER REGIME UNDER FURROW IRRIGATION, For primary bibliographic entry see Field 2G. W91-10017

COMPUTATIONAL HYDROLOGY '87, Proceedings of the 1st International Conference, Anaheim, California, July 1987. Lighthouse Publications, Mission Viejo. 1987. 247p. Edited by T. V. Hromadka and R. H. McCuen.

Descriptors: \*Computer programs, \*Conferences, \*Data interpretation, \*Data processing, \*Ground-water movement, \*Hydrologic models, \*Model studies, \*Surface flow, Flood control, Fluvial sediments, Mathematical analysis, Mathematical studies, Optimization, Sedimentation, Solute transport, Storm water management, Urban watersheds, Water storage.

The edited proceedings are presented for the First International Conference on Computational Hydrology held in Anaheim, California in July, 1987. The objective of the conference was to provide those people involved in the use and development of water resources computer software a forum in which to discuss current trends in software usage, and also to consider the goals of future software design. A total of ten sessions made up the conference. The sessions included the following topics: (1) Hydrologic Modeling: Methods and Issues; (2) Sedimentation and Fluvial Processes; (3) Urban Watershed Modeling; (4) Computational Methods in Groundwater Modeling; (5) Computational Methods in Surface Water Flow; (6) Municipal Flood Control Modeling; (7) Contaminant Transport Modeling and Procedures; (8) Computational Methods in Storage System Modeling; (9) Stormwater Management System Optimization; and, (10) Detention Basin Modeling and Optimization. The conference was sponsored by the Computational Hydrology Institute of Irvine, California. (See W91-10019 thru W91-10058) (Korn-PTT)

S-GRAPH STUDY FOR MARICOPA COUNTY, ARIZONA.

ARIZONA.

Maricopa County Flood Control District, Phoenix,
AZ.

For primary bibliographic entry see Field 4A.

W91-10019

MODELING SNOWMELT-RUNOFF AND LAKE EVAPORATION USING SATELLITE

DATA.
Brigham Young Univ., Provo, UT. Dept. of Civil
Engineering.
A. W. Miller, and D. J. Sereno.

In: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A7-A13. 11 fig, 1 tab, 10 ref.

Descriptors: \*Lake evaporation, \*Model studies, \*Remote sensing, \*Runoff, \*Satellite technology, \*Snowmelt, Climatology, Data interpretation,

Evaporation, Heat Capacity Mapping Mission (HCMM), Hydrographs, Hydrologic models, Infrared imagery, Lakes, Landsat images, Snow, Snow cover.

Significant progress has been made in the application of satellite remote sensing data to the field of hydrology. Water has unique spectral responses at various wavelength ranges (bands) which make it conducive to evaluations from satellite data. The Martinec-Rango Snowmelt-Runoff Model (SRM), which uses snow-cover area derived from Landsat satellite images, was applied to 4 basins within Utah. The runoff season of 1983 was chosen for study because of the record high snowpack and peak flow rates. The simulation accuracy was very good as evidenced by the high daily discharge R-squared values, and the small difference between measured and simulated runoff volumes. Without the benefit of more complete Landsat snowcover imagery, and despite the unavailability of more representative basin climatological data, SRM appears to be effective in these cases. In addition, satellite thermal infrared data acquired by the Heat Capacity Mapping Mission (HCMM) satellite were used to develop equations for estimation of lake surface evaporation. These models were for both day and night satellite data. Attempts to use the thermal data as direct input to theoretical evaporation equations were also made. Correlations of both day and night average HCMM surface temperature and evaporation were excellent. Satellite thermal data have significant potential for improving estimates of lake evaporation. The ability to measure lake surface temperatures with thermal infrared sensors on satellites has direct application to studies of lake dynamics and climatology. (See also W91-10018) (Korn-PTT)

LOWER MISSISSIPPI RIVER STAGES FORE-CASTING SYSTEM.

Tulane Univ., New Orleans, LA. Dept. of Civil Engineering.
C. Grimwood.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A14-A17. 3 fig. U. S. Army Corps of Engineers Contract No. DACW 29-83-0162.

Descriptors: \*Atchafalaya River, \*Data interpretation, \*Flood forecasting, \*Mississippi River, \*Model studies, \*River forecasting, \*Rivers, \*Streamflow, \*Streamflow forecasting, \*Surfect ewater, Computer programs, Forecasting, Hydrologic models, Mathematical analysis, Mathematical studies, River flow, Stream gages.

A computerized method of forecasting stages based on gage relations between stations along the stream was developed for the Lower Mississippi and Atchafalaya Rivers. The method was designed to model the judgement of experienced stage forecasters that have used gage relations successfully in the New Orleans District of the Corps of Engineers for many years. Stages observed at the stations of interest since 1973 were computerized and from this data bank, the River Stage Forecasting System selected the best match for the stages observed at the first upstream station for the prediction period. The selected stages were then routed downstream through the station of interest; the effects of operating a control structure and emergency spillways were factored into the system. The system provided the flexibility to change the initial station and the lag times between stations, and to adjust stages at selected locations. However, there were some factors that an experienced forecaster could introduce into the prediction that would be impractical to incorporate into a computer program. For example, prior knowledge of a floodwave traveling toward the main stream through an upstream tributary can only be introduced into the prediction as a subjectively estimated correction factor. The program developed for this project makes provisions for the manual introduction of correction factors to the predicted stages. (See also W91-10018) (Korn-PTT)

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CONFIDENCE INTERVALS FOR FLOODS, California Univ., Irvine. Dept. of Mathematics. R. Whitley, and T. V. Hromadka. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A18-A20. 1

Descriptors: \*Confidence intervals, \*Data interpretation, \*Flood forecasting, \*Statistical analysis, \*Statistical methods, Flood control, Flood protection, Floods, Hydrologic models, Mathematical studies, Model studies, Simulation analysis, Statistical models, Uncertainty.

Flood control agencies generally select a flood protection standard, for example the 100-year flood, to be used in the design of local flood control facilities. Estimating the T-year peak flow rate is required to comply with this standard. However, there is uncertainty in the estimation of the size of the T-year flood due to the uncertain. estimation of the parameters in the Log Pearson III distribution which describes the occurrence of the maximum annual discharge. A program has been developed which describes empirical confidence intervals for the T-year flood by means of a simulation. The results of the simulation were found to be more accurate and covered a more extensive range more accurate and covered a more extensive range of T, sample sizes, skews, and levels of significance than other simulations. Therefore, it was determined that confidence intervals should be provided for design values of the T-year flood and they could be computed by simulation or, for the usual range of hydrologic parameters, by the Stedinger-Kite approximation. (See also W91-10018) (Korn-PTT) PTT) W91-10022

APPLICATION OF MICROCOMPUTER PROGRAMS FOR PEAK DISCHARGE CALCULA-TION.

North Carolina Univ. at Charlotte. Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-10023

YEARS OF COMPUTERIZATION-A CASE STUDY.

ASL Engineering, Inc., Santa Barbara, CA. W. Bennett.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A25-A26.

Descriptors: \*Automation, \*Computers, \*Data processing, \*Management planning, Accounting, Case studies, Civil engineering, Computer programs, Cost analysis, Costs, Mathematical analysis, Mathematical studies, Microcomputers.

In 1977, a private civil engineering firm was on the verge of automating time proven methods of per-forming engineering calculations. Prior to 1977, good judgement, hand calculations and brute force were relied upon to accomplish design tasks. Soft-ware requirements at the time included hydraulics, ware requirements at the time included hydraulics, network analysis, coordinate geometry and structural analysis. The initial costs of in-house systems vs. the availability of time share companies directed the firm toward contract agreements with several time share companies which offered a variety of software packages. However, eventually it became apparent that time-sharing resulted in significant costs. In 1981, a microcomputer was purchased which offered faster response time and inexpensive data processing. This purchase signaled the beginning of the end of the company's time share dependency. Over the past 10 years, the firm has progressed from virtually no in-house hardware to a sophisticated state-of-the-art decentralized data processing system which services all tralized data processing system which services all three offices, and corporate accounting. The system continues to evolve toward an ultimate goal of designer workstations and efficient computer-aided drafting applications. (See also W91-10018) (Korn-PTT)
W91-10024

WATER RESOURCES COMPUTER SOFT-WARE: THE FIRST PARTY AND THIRD PARTY LIABILITY OF THE LICENSEE AND

Davis and DiGrazia, Laguna Hills, California. For primary bibliographic entry see Field 6E. W91-10025

COMPLEX WATERSHED MODELS IN FLOOD CONTROL: QUESTIONS OF CREDIBILITY. California State Univ., Fullerton. Dept. of Applied

Mathematics. T. V. Hromadka.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A34-A37. 12

Descriptors: \*Data interpretation, \*Flood control, \*Hydrologic models, \*Model studies, \*Precision, \*Storm runoff, California, Design storms, Handbooks, Hydrograph analysis, Hydrographs, Literature review, Surface water, Unit hydrographs, Urban runoff, Urbanization, Variability.

The flood control agencies of two large counties in The mood control agencies or two large countes in California have recently completed a major study effort in the development of a flood control Hy-drology Manual. The manual describes the meth-ods and procedures to be used for all hydrology studies prepared for projects within the counties of Orange and San Bernardino. Included in the process is the evaluation of all available canned hydrology computer programs and the selection of a particular model. Of the over 100 models available, particular mode. Of the over 100 modes a variation, a design storm/unit hydrograph model is currently the most widely used modeling technique among practitioners. Some of the reasons are: (1) the design storm approach—the multiple discrete event and continuous simulation categories of models have not been clearly established to provide better nave not been clearly established to provide better predictions of flood flow frequency estimates for evaluating the impact of urbanization and for design flood control systems than a calibrated design storm model; (2) the unit hydrograph-method it has not been shown that the kinematic wave modeling technique provides a significantly better representation of watershed hydrologic response than a model based on unit hydrographs (locally calibrated or regionally calibrated) that represent free-draining catchments; (3) model usage—the 'model' has been used extensively nationwide and has proved generally asceptable and reliable; (4) parameter calibration; (5) calibration effort—the 'model' does not require large data or time requirements for calibration; (6) application effort; (7) acceptability; and (8) model certainty evaluation--the certainty of modeling results can be readily evaluated as a distribution of possible outcomes over the probabilistic distribution of parameter values. (See also W91-10018) (Korn-PTT) W91-10026

INCLUDING UNCERTAINTY IN HYDROLOGY CRITERION VARIABLE PREDICTIONS. Williamson and Schmid, Irvine, CA.

T. V. Hromadka.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p A38-A42. 3

Descriptors: \*Data interpretation, \*Hydrograph analysis, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Statistical analysis, \*Uncertainty, \*Unit hydrographs, Channel flow, Distribution, Hydrographs, Hydrology, Prediction, Runoff, Surface runoff.

The classic single area unit hydrograph (UH) approach to modeling runoff response from a free draining catchment is shown to represent several important modeling considerations including: (1) subarea runoff response (in a discretized model). (2) the subarea effective rainfall distribution includ-ing variations in magnitude, timing, and storm pattern shape, (3) channel flow routing translations and storage effects, using the linear routing technique, and (4) subarea runoff hydrograph addition. Because the UH method correlates the effective rainfall distribution to the runoff hydrograph distribution, the resulting catchment UH should be considered a correlation distribution in a probabi-listic sense. Should the uncertainty in rainfall over the catchment be a major concern in modeling reliability, then the output in the predictive setting must be considered to be a random variable. (See also W91-10018) (Author's abstract) W91-10027

FLUVIAL DESIGN OF RIVER BANK PROTEC-TION FOR SANTA CRUZ RIVER.

San Diego State Univ., CA. Dept. of Civil Engi-

H. H. Chang, and Z. Osmolski.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p B1-B5. 6 fig, 6

Descriptors: \*Bank protection, \*Channel stability, \*Design criteria, \*Design floods, \*Design standards, \*Flood control, \*Flow profiles, \*Model studies, \*Santa Cruz River, Arizona, Channel scour, Channelization, Channels, Grading, Hydraulic structures, Hydrology, Mathematical models, Sediment, Lond Sediment, temporar, Sedimentation ment load, Sediment transport, Sedimentation, Simulation analysis, Stream banks, Surface water.

The Santa Cruz River in Pima County, Arizona, flows through the City of Tucson. The river changed dramatically in character during the October 1983 flood during which the river reached the 100-yr magnitude at many locations. To pro-vide river flood control, Pima County officials have authorized the characterization of the Santa Cruz River from the confluence of the Rillito River to Martinez Hills. Stabilization of the river was based upon bank protection and grade con-trols structures designed to contain the design flood and extend below the potential river-bed scour. Simulated results indicate that river bed scour is related to the flow curvature. Maximum scour is reached at the bend exit, followed by a gradual decrease in transverse bed slope and scour depth with the decline in flow curvature. While techn with the decline in low curvature. Withe the scour depth was found to be generally in direct relation to the flow curvature, river bed evolution is also affected by scour and fill which are provoked by the longitudinal imbalance in sediment load. Spatial variation in sediment load in the Santa Cruz River was found to be significant, and con-tributes to scour and fill development. The top and toe elevations of bank protection were selected on the basis of the simulated results and the computed maximum channel bed scour plus one half of the wave height for antidunes and a safety margin of about 6 ft. For a velocity of 13 ft/sec, the wave height is about 2.3 ft. An important feature of this design is the variable toe elevation used to account for the difference in scour depth between the concave and convect banks; this design scheme provides more effective protection against channel bed scour. (See also W91-10018) (Author's abstract) W91-10028

URBAN WATERSHED RAINFALL-RUNOFF MODELING: A CASE STUDY.

Texas A and I Univ., Kingsville R. Y. Tokuz.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p C1-C3. 3 ref.

Descriptors: \*Flood plain management, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Storm runoff, \*Urban hydrology, \*Urban watersheds, Culverts, Data interpretation, Nonstructural alternatives, Rainfall, Storm sewers, Streamflow, Surface runoff.

The Knights Branch watershed is located in Dallas, Texas, and covers an area of about 5 square miles. There are no available streamflow data available for this watershed. Therefore, during the preparation of a flood plain management report, the flood runoffs had to be calculated from rainfall data. The two computer programs were used for rainfall-runoff modeling were originally developed for rural watersheds, and were not able to model the flows in the horse-shoe storm sewers present in the area. The Water Surface Profile Program, se-lected for use, does not calculate the flow through storm sewers. Therefore, sewers had to be includ-ed in the model as 'culverts'. But only one crosssection may be described over the culvert: the roadway. When a culvert extends several thousand feet, the program cannot simulate the system accurately. In such cases, it was necessary to calculate

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the water surface profiles assuming that no storm sewer exists, and then the rating curves developed sewer exists, and then the rating curves developed in this manner were superimposed on top of the enclosed section. The flood routing calculations decided how much of the total discharge flows into the storm sewer and how flows overland. The Runoff Generation and Flood Routing Program provides the 100-yr flood discharge values for the 'routing points'. Only a small fraction of the cross-sections used in the Water Surface Profile Program were included in the flood routine calculations as were included in the flood routing calculations as routing points. The computation of discharges for sections other than routing points requires an inter-polation procedure which involves log discharge versus log drainage area straight-line interpolation between two routing points. Another difficulty perween two roung points. Another difficulty encountered in this study was due to the constraints set up by the City of Dallas. Since the City rejects the possible increase in the sump storage capacity in the old channel of the Trinity River, and since adding more pumping capacity to convey the flood waters into the new channel is very costly, it was necessary to develop a flood management plan which does not increase the flow volumes for design flood. Therefore, the existing storage capacity in the watershed had to be main-tained. (See also W91-10018) (Korn-PTT) W91-10029

OPTIMAL DESIGN OF STORM DRAIN SYS-

ASL Consulting Engineers Pasadena, CA. For primary bibliographic entry see Field 4A. W91-10030

APPLICATION OF SMALL AREA UNIT HYDROGRAPH METHOD.

DROGRAPH METHOD.
King Civil Engineering Corp., Placentia, CA.
T.A. King.
IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p C9-C18. 8 fig,

Descriptors: \*Data interpretation, \*Hydrologic models, \*Model studies, \*Surface runoff, \*Unit hydrographs, Catchment areas, Computer programs, Design storms, Drainage area, Hydrograph analysis, Hydrographs, Mathematical analysis, Mathematical studies, Rainfall, Rainfall-runoff relationships, Pageoff. lationships, Runoff.

The small area runoff hydrograph may be used for watersheds whose time of concentration is less than 25 minutes. The time of concentration is generated by the use of the rational method, and generated by the use of the rational menod, and regionalized point rainfall depths are used without depth-area adjustments. The unit interval for this hydrograph is equal to the rational method time of concentration (Tc). Unit rainfalls are determined by successive subtracting along the mass rainfall plot, loss rates conform to the governing bodies procedures for calculating loss rates. The unit hy-drograph is determined to be a triangle with a base of 2 Tc and a peak discharge (Q) at time Tc-the resultant volume is the area of the triangle. Convolistinal volume is the area of the triangle. Convo-lution of the unit hydrograph with the unit effec-tive rainfall is simply the addition of peak runoff values at each of the Tc unit intervals and peak flow estimates follow from the ration method. In the small area hydrograph method, the total catch-ment area is used in the calculation of peak flow and the design storm patters is based on a single and the design storm pattern is based on a single synthetic 24 hour critical storm pattern where the peak unit rainfall begins at the sixteenth hour. The peak unit rainfail oggins at he statement nour. The pattern continues by placing subsequent peak unit periods on either side of the sixteenth hour. To begin the process, the next two unit periods are placed to the left of the sixteenth hour, and the placed to the left of the sixteenth flour, and the third peak period is placed to the right of the sixteenth hour. Continue the pattern, placing two peak unit periods to the left and one to the right until the complete 24 hour peak unit periods are placed. (See also W91-10018) (Korn-PTT) W91-10031

MASTER PLAN OF DRAINAGE-APPLICA-TION OF A USER-FRIENDLY COMPUTER

Advanced Engineering Software, Irvine, CA. M. H. Seits, and T. V. Hromadka.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p C19-C25. 4 fig, 1 tab, 3 ref.

Descriptors: \*Computer models, \*Drainage, \*Land use, \*Management planning, \*Model studies, \*Surface runoff, \*Urban runoff, \*Water management, race runoii, "Uroan runoii, "water management, Case studies, Computer programs, Computers, Costs, Design criteria, Flood control, Hydrology, Mathematical analysis, Mathematical studies, Plan-ning, Runoff, Urban watersheds.

With land development, issues of how to control changes in runoff quantity have resulted in the development of policy statements that stipulate the design criteria for flood control. In order to implement a regional flood control system, an assessment based on property holdings (or other policy statement) is used to generate long-term income for the construction of the project facilities. With the use of an advanced, highly interactive computer program (i.e., RATNAT), the development of a computerized master plan of drainage (MPD) can easily provide the necessary information on which easily provide the necessary information on which to base the drainage fees. Once the MPD model has been developed, modifications to the water-shed (i.e., storm drain alignments, development types, etc.) can easily be incorporated into the model and drainage fees updated if necessary. (See also W91-10018) (Korn-PTT)

COMPARISON OF STREAMFLOW ROUTING PROCEDURES FOR HYDROLOGIC MODELS. California Univ., Davis. Water Resources Center. J. J. DeVries, and T. V. Hromadka. IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p C26-C33. 8

Descriptors: \*Data interpretation, \*Hydrologic models, \*Kinematic wave theory, \*Model studies, \*Open-channel flow, \*Routing, \*Streamflow, \*Urban hydrology, Comparison studies, Hydrology, Mathematical analysis, Runoff, Unsteady flow, Urban watersheds.

Urban watersheds.

Models of watershed runoff typically include a submodel for approximating the effects of unsteady flow in open channels for routing computed runoff through a channel reach. The standard kinematic wave (KW) method is a popular hydrologic method used in watershed models while the convex method is a popular hydrologic channel routing model. The KW routing method was compared to the standard convex routing method in terms of the standard convex routing method in terms of the standard convex routing method in terms of the standard convex routing method in computational effort. Data revealed that a wide range of results were possible from a KW model, dependent on the choice of computational reach length and timestep size used in the KW approximation. However, the simple convex hydrologic routing method demonstrated only a small fraction of the variation in results as compared to the KW model. It was recommended that the use of the KW method for channel routing in watershed KW method for channel routing in watershed models be re-evaluated as to their credibility and reliability in typical flood control designs. (See also W91-10018) (Korn-PTT) W91-10033

CHARACTERIZATION AND CONTROL OF SHALLOW GROUND WATER CONDITIONS. Leighton and Associates, Inc., Irvine, CA. For primary bibliographic entry see Field 2F.

EVALUATION OF GROUNDWATER FLOW CONDITIONS IN THE SAN GABRIEL BASIN, CALIFORNIA, USING A THREE DIMENSION-AL NUMERICAL MODEL. CH2M Hill, Santa Ana, CA.

For primary bibliographic entry see Field 2F. W91-10035

RIVER BASIN MODELING VIA SYSTEMS ANALYSIS AND ARTIFICIAL INTELLI-ANALYSIS GENCE.

Montana State Univ., Bozeman. Dept. of Industrial and Management Engineering. D. W. Boyd.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p E1-E10. 2 fig, 3 tab. 10 ref.

Descriptors: \*Artificial intelligence, \*Data interpretation, \*Decision support systems, \*Model studies, \*Planning, \*Systems analysis, \*Watershed management, Decision making, Regression analysis, River basins, Statistical analysis, Theoretical

Decision support systems for river basin planning are limited by data and methodology. Data shortness is an accepted constraint, but greater success is possible through refined methodology. Three approaches to river basin modeling that differ in their treatment of detail include: theoretical analysis, regression analysis, and systems analysis. The greatest potential for enhancement lies with sysgreatest potential for enhancement lies with sys-tems analysis coupled with artificial intelligence techniques. Data-based modeling will be replaced by knowledge-based modeling. First, the knowl-edge base captures the results of a thorough systems analysis and is arranged in hierarchical order. Each homogeneous level of the knowledge base supports a model which articulates river basin variables at the corresponding level of detail. Second, ables at the corresponding level of detail. Second, the knowledge base incorporates learning, inferences based on the system's current knowledge, and becomes 'smarter' with progressive iteration. The inference system involves 'reverse regression' which serves as an external expert system to deduce model structure, then given the structure, to complete the database. The model is validated by subjecting its output to a Turing type test. The 'nuisance' of completing a thorough systems analysis is compensated for in several ways. The system of linear equations is extremely accurate in reproof linear equations is extremely accurate in reproducing the nonlinear response of basin variables. Solution of the equations is accomplished by Solution of the equations is accompanied by matrix inversion and is very cost-effective. Flexibility is another useful feature, permitting the model to be linked for interaction with other similarly structured models. (See also W91-10018) (Korn-PTT) W91-10037

WATER SURFACE PROFILES IN ICE COVERED RIVERS,

Michigan Technological Univ., Houghton. Dept.

of Civil Engineering.
For primary bibliographic entry see Field 2C.
W91-10038

HIGH STABILITY SPATIAL DISCRETIZA-TION FOR HYPERBOLIC PROBLEMS. Notre Dame Univ., IN. Dept. of Civil Engineer-

I. P. E. Kinnmark.

I. P. E. Kinmark.
IN: Computational Hydrology '87. Lighthouse
Publications, Mission Viejo. 1987. p E18-E25. 6
fig. 1 tab, 10 ref. National Science Foundation
Grant No. CEE-8419366.

Descriptors: \*Data interpretation, \*Mathematical analysis, \*Mathematical models, \*Mathematical studies, \*Model studies, \*Simulation analysis, Computer programs, Computers, Differential equations, Finite element method, Hydrology, Microcomputers, Open-channel flow, Shallow water equations, Surface flow, Surface water.

Hyperbolic and hyperbolic-dominated problems abound in surface water flow and surface and subsurface transport. Mathematical simulation models of these phenomena require efficient computational techniques to accommodate field scale simulations and/or use of microcomputers. In the context of earlieit time, praching procedures for simulations and/or use of microcomputers. In the context of explicit time marching procedures for the time evolution in mathematical models, efficiency is often limited by the maximum stable time step size. Therefore efficiency translates into computational procedures of a highly stable type. A technique has been developed to increase the stability while preserving accuracy, for higher order finite elements. One scheme is obtained for quadratic Lagrangian finite elements which allows a

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three-fold increase of allowable charge in time (delta t) squared over the standard quadratic La-grangian, and a two-fold increase in delta t squared compared to the linear (Chapeau) basis function, thus unleashing the inherent efficiency increase in utilizing higher order elements with increased con-nectivity. In an application to a one-dimensional open channel flow problem, the theoretically ob-tained increased stability limit was obtained experimentally. Therefore, the new scheme was shown to provide an accurate solution. (See also W91-10018) (Author's abstract)

THEORY FOR DEVELOPMENT OF THE TR-55 TABULAR HYDROGRAPH METHOD. Haestad Methods, Westbury, CT.

M. K. Glazner.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p E26-E35. 8

Descriptors: \*Computer models, \*Data interpreta-tion, \*Data processing, \*Hydrograph analysis, \*Hydrographs, \*Model studies, \*Rainfall-runoff relationships, \*Urban hydrology, Computer pro-grams, Drainage area, Flood peak, Hydrology, Precipitation, Rainfall distribution, Runoff, Stor-Surface flow, Watershed management, Water-

Technical Release No. 55 (TR-55), 'Urban Hydrology for Small Watersheds', was originally developed by the United States Soil Conservation Servoped by the United States Soil Conservation Service (SCS) in the 1970's (revised in June of 1986) to provide practical solutions for a wide variety of small watershed hydrology problems including: computation of peak discharge, hydrograph generation, reach routing, and detention storage estimates. The TR-55 generates pre-developed and post-developed hydrographs for small watersheds. It is an ideal method for evaluating small drainage areas where computer models such as TR-20 may arouse to be too destailed. The method accounts for prove to be too detailed. The method accounts for initial abstraction and precipitation, time of concentration, and travel time (reach routing effects). The TR-55 was developed from numerous TR-20 The TR-55 was developed from numerous TR-20 runs using a 24-hour storm duration and a drainage area of one square mile with different time of concentration (Tc), travel time (Tt), initial abstraction and precipitation effects (Ia/Ps), and distribution types. The TR-20 reach routings were done in a stepped fashion to approximate the average results from computer runs that used state-of-the-art dynamic wave routing techniques. (See also W91dynamic wave routing techniques. (See also W91-10018) (Korn-PTT)

WE NEED A HYDROLOGY MANUAL.

Floodplain Management Division, Kern County Department of Planning and Development Services. California J. R. Hogg.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p F1-F5. 2 fig, 4

Descriptors: \*Data interpretation, \*Flood plain management, \*Handbooks, \*Hydrologic models, \*Model studies, \*Urban hydrology, Data acquisi-tion, Flood control, Runoff, Storms.

Kern County, California, has 3 distrinctive hydrologic areas and several storm types, with a variety of modeling techniques available to calculate runoff peaks and volumes. The basic goal of the Floodplain Management Division of the Department of Planning and Development Services is to minimize flood damage by a coordinated blend of floodplain management and structural projects. This basic seal is consistent with current parieties. This basic goal is consistent with current national and state policies. The need to support such a program with hydrologic information is complicated by a lack of dependable guidelines. Due to the wide variety of hydrologic models available, it has become important to select a modeling technique oecome important to select a modeling technique or techniques and publish them in a hydrology manual for region-wide applications. Kern Coun-ty's hydrology manual will serve to provide a cohesive, accessible source of hydrologic data and analysis. It will draw all of the information-stream

gauge, precipitation and modeling techniques to-gether into one standard, which is acceptable for national and local applications. (See also W91-10018) (Korn-PTT)

NUMERICAL MODELING OF ARID REGION FLOOD HAZARDS. Simons, Li and Associates, Inc., Newport Beach,

For primary bibliographic entry see Field 2E.

W91-10042

HYDROGEOLOGIC ANALYSIS OF UNION CARBIDE'S A-19 PIT, EAST GAS HILLS, WYO-

Idaho Univ., Moscow. Dept. of Agricultural Engi-

For primary bibliographic entry see Field 4C. W91-10043

MODELING THE VERTICAL TRANSPORT AND FATE OF LOW-WATER SOLUBILITY TOXIC CHEMICALS IN A SHALLOW UNCON-FINED AQUIFER.

Oregon State Univ., Corvallis. Dept. of Mathemat-

For primary bibliographic entry see Field 5B. W91-10045

CVBEM ANALYSIS IN SUBSURFACE HYDRAULICS.

Williamson and Schmid, Irvine, CA.
C. C. Yen, and T. V. Hromadka.
IN: Computational Hydrology '87. Lighthouse
Publications, Mission Viejo. 1987. p G21-G24. 8

Descriptors: \*Boundary conditions, \*Groundwater movement, \*Mathematical analysis, \*Mathematical models, \*Model studies, Computers, Data interpre-tation, Hydraulics, Laplace equation, Mass trans-port, Mathematical studies, Numerical analysis, Spatial distribution, Subsurface water.

The Complex Variable Boundary Element Method (CVBEM) provides solutions to two-dimensional potential problems. Unique to this method is the Complex Variable Boundary Element Method potential problems. Unique to this method is the approximate boundary which represents the true problem boundary transformed to the spatial configuration where the problem's boundary conditions are satisfied. This deforming approximate boundary indicates a true measure of numerical accuracy which is easy to interpret and under-stand. The CVBEM was used to develop a twodimensional, steady-state, subsurface flow model. With the CVBEM approach, the Laplace equation is solved exactly and all modeling errors occur in matching the prescribed boundary conditions. The approach is based upon a boundary integral equa-tion; domain mesh generators or control-volume tion; domain mean generators or control-volume (finite element) discretizations are not required. Nodal points are required only along the problem boundary rather than in the interior of the domain. Consequently, the computer-coding requirements are small and can be accommodated by many personal computers that support a Fortran compiler. er. The numerical analog can also be extended to other equivalent problems such as involved in heat and mass transport problems. (See also W91-10018) (Korn-PTT) W91-10046

STORMWATER RETENTION CRITERION FOR URBAN DRAINAGE BASIN MANAGE-

Erie and Associates, Phoenix, AZ. For primary bibliographic entry see Field 4A. W91-10048

DISCRETE OPTIMAL CONSTANT-VOLUME CONTROL FOR IRRIGATION CANALS.

Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
J. M. Reddy.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p H9-H16. 14

fig, 7 ref.

Descriptors: \*Automation, \*Flow models, \*Irriga-tion canals, \*Irrigation design, \*Mathematical models, \*Model studies, \*Open-channel flow, \*St Venant equation, \*Stage-discharge relations, Math-ematical analysis, Mathematical equations, Mathe-matical studies, Model testing, Optimization, Ric-cati equation, Water level.

A lumped parameter model based upon the linear-ized Saint-Venant equations has been developed for the automatic operation of irrigation canals. The state equations were derived for the lumped parameter model. Using a cost minimization function, the problem was formulated as a steady-state discrete optimal control problem, and the solution discrete optimal control problem, and the solution was obtained by solving the algebraic Riccati equation. An example problem was considered, and variations in the depth of flow obtained using the optimal control theory were compared with the results obtained from an unsteady open-channel flow model. For small and slow changes in flow rate, the difference between the two models in seedicting the changes in water surface alexation. predicting the changes in water surface elevation was negligible. However, as the transfers between was negligible. However, as the trainers setwer the reaches eased, the accuracy of the optimal control model (which is based upon the linearized Saint-Venant equations) in predicting water surface elevations decreased. (See also W91-10018) (Author's abstract) W91-10049

NWS DAMBREAK OR NWS SIMPLIFIED DAM BREACH.

Missouri Univ.-Rolla. Dept. of Civil Engineering. J. A. Westphal, and D. B. Thompson.
IN: Computational Hydrology '87. Lighthouse
Publications, Mission Viejo. 1987. p H17-H23. 10 fig. 4 ref.

Descriptors: \*Computer models, \*Dam failure, \*Flood discharge, \*Flood forecasting, \*Flood peak, \*Flood waves, \*Model studies, Case studies, Computer programs, Dams, Error analysis, Errors, Flood control, Hydraulic structures, Maps, Misters of the control of the souri, Reservoirs, Simulation, Topography.

Due to the dynamic nature of breach-induced floods, digital models which are based on the conservation of both mass and momentum are preferable for breach analysis. Results obtained from the National Weather Service (NWS) Simplified Dam Break Flood Forecasting Model (SDB) and the NWS Dam-Break Flood Forecasting Model (DAMBRK) were compared for systematic bias and to establish guidelines for using SDB in place of DAMBRK. The comparisons were made using DAMBRK as a baseline. One set of comparisons was made using an assumed set of hypothetical reservoirs with downstream environments constructed to match the simplified geometry used in SDB. Another set used six Missouri dams with cross-section data scaled from 7-1/2 minute topographic maps. On four of these, comparisons were servation of both mass and momentum are preferacross-section data scaled from 7-1/2 minute topo-graphic maps. On four of these, comparisons were also based on simulations using surveyed cross sections. Average errors in peak discharge substan-tially exceeded ten percent for hypothetical sys-tems. Average absolute errors in peak stage were about 7.3 percent, with a tendency for overestima-tion. Using data from Miscouri dame, the absolute about 7.5 percent, with a tendency for overestima-tion. Using data from Missouri dams, the absolute error in peak flow rate averaged 12.7 percent. Errors in peak depth ranged from 4.7 feet to +6.8 feet using topographic data and from 4.8 feet to +4.8 feet using surveyed data. Results of the investigation also revealed that DAMBRK should be used for those cases in which hydraulic controls or used for those cases in which hydraunic controls or off-channel storage may influence the dam breach analysis. In addition, DAMBRK should be used for detailed analysis when SDB simulations result in peak stages that are within five feet of any structure used to define or classify the potential zone of inundation. Otherwise, use of SDB will be faster and less expensive. (See also W91-10018) (Author's abstract) W91-10050

SIMULATION MODELING AND DATA COL-LECTION IMPACTS ON RESERVOIR CONTROL DECISIONS,

#### Evaluation, Processing and Publication—Group 7C

Corps of Engineers, Detroit, MI. Detroit District. For primary bibliographic entry see Field 4A. W91-10051

FINANCIAL COMPUTER MODEL FOR STORMWATER MANAGEMENT ANALYSIS. Georgia Inst. of Tech., Atlanta. For primary bibliographic entry see Field 6C. W91-10052

INTEGRATION OF REAL-TIME FORECAST-ING AND ENGINEERING WORKSTATIONS. International Hydrological Services, Sacramento,

For primary bibliographic entry see Field 7B.

DEM DATA USED TO DEVELOP RUNOFF IN AREAS OF DEPRESSIONAL STORAGE. Bureau of Reclamation, Billings, MT. For primary bibliographic entry see Field 7B. W91-10055

EFFECT OF DETENTION BASINS ON PEAK WATERSHED DISCHARGES.
Renninger (William) Associates, Greenville, SC.

For primary bibliographic entry see Field 4A. W91-10056

SPILL: A DECISION SUPPORT SYSTEM FOR DESIGN AND EVALUATION OF SPILLWAYS. Colorado Univ. at Boulder. Center for Advanced Decison Support for Water and Environmental

For primary bibliographic entry see Field 8A. W91-10057

APPLICATION OF A SIMPLE WEIR STRUC-TURE FLOODFLOW BYPASS ANALYSIS PRO-GRAM.

Williamson and Schmid, Irvine, CA W. V. Burchard.

IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p J20-J24. 6 fig, 3 tab, append.

Descriptors: \*Bypass channels, \*Channel flow, "Computer programs, "Data interpretation,
"Design criteria, "Hydraulic structures, "Weirs,
Alternative planning, Channel inflow, Computer
models, Cost analysis, Cost-benefit analysis, Design
standards, Excavation, Hydraulics, Structural engineering, Structural models.

A simple interactive weir structure floodflow bypass analysis program was applied to estimate the amount of water that would spill over a weir wall for a given inflow into the channel. The program provides the user the ability to estimate the optimum weir wall height to meet design requirements by calculating the channel outflow and weir capture flows for a given channel inflow. In addition, the use of the weir overflow analysis program provides the ability to create a cost-to-benefit curve. The advantage of developing this curve is that the optimum design, in terms of efficiency and cost, can be determined. The analysis program was used in the design of the Galivan Retarding Basin and was designed to model the A simple interactive weir structure floodflow Retarding Basin and was designed to model the transfer of excess flows from Oso Creek into the Galivan Retarding Basin via a weir structure. From several alternative design studies, an extended weir concept was selected in which the length of the weir was determined by comparing the cost of excavation and any savings realized in excavation, by the reduction in excess flows with excavation, by the reduction in excess flows with the cost of any given weir length. After selecting several weir lengths, their corresponding weir heights were estimated by varying the weir height in the hydraulic calculations for each arbitrary weir length chosen. The point that made this alter-native most economically feasible was the ability to greatly vary the length of the weir which allow-ing for an optimum weir length to be selected. (See also W91-10018) (Korn-PTT) W91-10058

ENDOW USER'S GUIDE.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. F. D. Shields, and T. E. Schaefer.

Available from the National Technical Information Service, Springfield, VA. 22161. Army Corps of Engineers Instruction Report W-90-1, December 1990. 49p, 17 fig, 18 ref, append.

Descriptors: \*Channel flow, \*Channel improvement, \*Computer programs, \*ENDOW computer program, \*Expert systems, \*Flood control, Bank stabilization, Levees, Streamflow.

ENDOW (Environmental Design of Waterways) is an expert system or knowledge-based computer program intended to aid planners and designers in learning and selecting environmental features for learning and selecting environmental teatures for stream channel alteration projects based on key project parameters and specific environmental goals. This report provides general instructions for installing and using ENDOW (Part II) and detailed information and examples for the streambank pro-tection, flood control channel, and streamside levee modules, respectively (Parts III through V). Appendix A contains a list of the engineers and scientists who have contributed to the develop-ment of ENDOW (See also W80.0542) (Lastrament of ENDOW. (See also W89-08542) (Lantz-PTT) W91-10060

COMPUTERIZATION OF THE DECISION-MAKING FRAMEWORK.

AScI Corp., Duluth, MN. For primary bibliographic entry see Field 6A. W91-10066

GEOHYDROLOGY OF THE SURFICIAL AQUIFER IN THE HORNELL AREA, IN STEU-BEN AND ALLEGHENY COUNTIES, NEW YORK.

For primary bibliographic entry see Field 2F. W91-10067

SATELLITE REMOTE SENSING FOR AGRI-CULTURAL PROJECTS.

International Bank for Reconstruction and Development, Washington, DC. For primary bibliographic entry see Field 7B. W91-10084

REMOTE SENSING ACTIVITIES IN THE WORLD BANK; A REVIEW OF EXPERIENCES AND CURRENT TECHNICAL CAPABILITIES. International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div.
For primary bibliographic entry see Field 7B.
W91-10085

LAND USE MAPPING IN THE PHILIPPINES USING SPOT SATELLITE IMAGERY.

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div.
For primary bibliographic entry see Field 7B.
W91-10087

MAPPING FROM SPACE. DIGIM, Inc., Montreal (Quebec). For primary bibliographic entry see Field 7B. W91-10088

INVENTORY OF SMALL AND MEDIUM-SIZE IRRIGATION SCHEMES IN ALGERIA USING SPOT NUMERICAL DATA.

For primary bibliographic entry see Field 7B. W91-10089

FAMINE IN AFRICA.

Foreign Agricultural Service, Washington, DC. For primary bibliographic entry see Field 7B.

REMOTE SENSING AND AGRICULTURAL IN-FORMATION FOR CROP FORECASTING: SUDAN EXPERIENCE.

International Bank for Reconstruction and Development, Washington, DC. Environmental Operopinion, washington, DC. Environmental (ations and Strategy Div. For primary bibliographic entry see Field 7B. W91-10095

USE OF REMOTE SENSING IN SURVEY, MANAGEMENT, AND ECONOMIC DEVELOP-MENT OF TROPICAL RAINFORESTS. For primary bibliographic entry see Field 7B. W91-10096

US AID: REMOTE SENSING AND FORESTRY. Agency for International Development, Washington, DC. Office of Science and Technology. For primary bibliographic entry see Field 7B. W91-10097

EARLY WARNING ON AGRICULTURAL PRO-DUCTION WITH SATELLITE DATA AND SIM-ULATION MODELS IN ZAMBIA. For primary bibliographic entry see Field 7B. W91-10100

INSTITUTIONAL ASPECTS OF REMOTE SENSING AND ENVIRONMENTAL DATA MANAGEMENT ISSUES AND RECOMMEN-

International Bank for Reconstruction and Development, Washington, DC. Environmental Operations and Strategy Div.
For primary bibliographic entry see Field 7B.
W91-10101

ELECTRO-HYDROLOGICAL ANALOGIES.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W91-10110

NONPARAMETRIC TECHNIQUES FOR ANALYSIS OF HYDROLOGICAL EVENTS. Ottawa Univ. (Ontario). Dept. of Civil Engineer-

For primary bibliographic entry see Field 2A. W91-10111

STATISTICAL ANALYSIS OF EXTREME EVENTS (ANALYSE STATISTIQUE D'EVENE-MENTS EXTREMES),

Laval Univ., Quebec. Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-10112

MULTIVARIATE EXTREME VALUE DISTRI-BUTIONS IN HYDROLOGICAL ANALYSES.

BUTIONS IN HYDROLOGICAL ANALYSES. Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria.

J. A. Raynal-Villasenor, and J. D. Salas.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 111-119, 2 tab, 20 ref.

Descriptors: \*Flood forecasting, \*Hydrologic models, \*Model studies, \*Multivariate analysis, \*Probability distribution, \*Pstatistics, Differential equations, Flood frequency, Mathematical studies, Parameter estimation, Parametric hydrology.

Recently, studies have commenced on the applica-tion of the multivariate approach to extreme value distributions towards its application for the solu-tion of hydrological problems. The theoretical foundations of such an approach were made some 20 years ago, but they have had very little impact on the field of hydrology. Two classes of bivariate extreme value distributions are now known: the differentiable and the nondifferentiable models. Nondifferentiable models do not have explicit probability density functions, which makes paramprobability density functions, which makes param-

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eter estimation difficult. The only two known differentiable models for bivariate extreme value distributions are: the logistic and mixed models. The logistic model is characterized by the fact that the reduced difference, when both marginals are Gumbel distributions, has the standard Logistic distribution in the first case. The mixed model has a dependence function coming from a mixture of a dependence intention coming from a mature of such functions for the cases of dependence and independence, when the marginals are Gumbel dis-tributions. Both these models, with appropriate multivariate extensions, may be applied to (1) iden-tification of the type of extreme value distributions; (2) improvement in parameter estimation; (3) transfer of extreme value information; and (4) flood frequency analysis downstream of river junctions. The use of multivariate extreme value distributions may improve the estimation of parameters of ex-treme value distributions. In addition to this feature, multivariate extreme value distributions pro-vide a means for the identification of such distribuvide a means for the identification of such distribu-tions in the univariate form. The third application uses the ability of such distributions to transfer information related with the extreme value data. Finally, this kind of distribution could be applied as an alternative to the solution of specific hydro-logical problems, e.g. a flood frequency analysis downstream of confluences. (See also W91-10103) W91-10114

EVALUATION OF PARSIMONIOUS STO-CHASTIC MODELS FOR RUNOFF FORE-CASTING AND SIMULATION IN TROPICAL ENVIRONMENTS, ZAMBIA.

Department of Water Affairs, Maseru (Lesotho). For primary bibliographic entry see Field 2E. W91-10116

APPLICATION OF OPTIMIZATION MODELS TO SYNTHETIC HYDROLOGICAL SAMPLES Ruhr Univ., Bochum (Germany, F.R.). Lehrstuhl fuer Waserwirtschaft und Umwelttechnik I. For primary bibliographic entry see Field 4A W91-10118

RIVER MECHANICS: A UNIVERSAL AP-PROACH.

Rand Afrikaans Univ., Johannesburg (South Africa). Systems Lab.

For primary bibliographic entry see Field 2E. W91-10119

TECHNICAL COOPERATION BETWEEN ITALY AND CHINA FOR THE IMPROVEMENT OF FLOOD FORECASTING.

C. Lotti & Associati, Via del Fiume 14 (passeggiata di Ripetta), 00186 Rome, Italy. For primary bibliographic entry see Field 2E. W91-10127

COLLECTING, PROCESSING, STORAGE AND ANALYSIS OF SELECTED HYDROLOGICAL DATA IN SWITZERLAND.

Service Hydrologique National, Bern (Switzerland).

For primary bibliographic entry see Field 7B. W91-10130

INPUT OF SYSTEMS SCIENCE TO HYDROL-

Polish Academy of Sciences, Warsaw. Inst. of Geophysics. For primary bibliographic entry see Field 2A. W91-10134

FUTURE OF RAINFALL-RUNOFF MODEL-LING IN ARID AREAS--LAKE EYRE CASE

South Australian Dept. of Engineering and Water Supply, Adelaide.

For primary bibliographic entry see Field 2B. W91-10135

SOME RECENT ADVANCES IN THE APPLI-CATION OF THE PRINCIPLE OF MAXIMUM ENTROPY (POME) IN HYDROLOGY. Louisiana State Univ., Baton Rouge. Dept. of Civil

Engineering.
V. P. Singh, and A. K. Rajagopal.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 353-364, 31 ref. ONR Contract N000-1486-WR-24-016.

Descriptors: \*Entropy, \*Hydrologic data, \*Hydrologic models, \*Model studies, \*Theoretical analysis, Estimating equations, Frequency distribution, Hydrologic data collections, Mathematical models, Network design, Parametric hydrology, Uncer-

The principle of maximum entropy (POME) developed in communication and information sciences open in communication and information sciences has recently been found to have wide ranging applications in hydrology and water resources. Some of these applications were made with respect to (1) derivation of frequency distributions, (2) parameter estimation, (3) evaluation of data acquisition systems, (4) derivation of functional relationships, and (5) assessment of uncertainty. It was shown that POME offers a unified approach to derivation of a number of frequency distributions used for hydrological analyses. Because hydrologiused for hydrological analyses. Because hydrologi-cal characteristics can be incorporated in the distri-butions, the approach can be applied to areas having limited data. This approach also yields a simple but useful method of parameter estimation, which is as good as the method of maximum likelihood estimation. Since POME can be applied to derive functional relationships between two or more variables, it has an advantage of performing multivariate stochastic analysis. Entropy measures the uncertainty of a mathematical model of the hydrological system, and is thus applicable to choosing between models and to designing hydro-logical networks for data collection. (See also W91-10103) (Author's abstract)

TOWARDS A NEW PARADIGM IN HYDROL-OGY.

Lancaster Univ. (England). Dept. of Environmental Sciences. For primary bibliographic entry see Field 2A. W91-10139

SOME REFLECTIONS ON THE FUTURE OF HYDROLOGY.

George Washington Univ., Washington, DC. For primary bibliographic entry see Field 2A. W91-10140

RESEARCH NEEDS IN CATCHMENT DIS-

TRIBUTED MODELLING.
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-10141

PARAMETER DETERMINATION AND INPUT ESTIMATION IN RAINFALL-RUNOFF MODELLING BASED ON REMOTE SENSING TECHNIQUES.

Ruhr Univ., Bochum (Germany, F.R.). For primary bibliographic entry see Field 2B. W91-10142

EXPERT SYSTEMS IN WATER RESOURCES. Georgia Inst. of Tech., Atlanta. School of Civil Engineering. For primary bibliographic entry see Field 6A. W91-10144

POINT PRECIPITATION MEASUREMENTS: WHY ARE THEY NOT CORRECTED.

Eidgenoessische Technische Hochschule, Zurich For primary bibliographic entry see Field 2B. W91-10146

U.S. GEOLOGICAL SURVEY'S NATIONAL SYSTEM FOR PROCESSING AND DISTRIBUTION OF NEAR REAL-TIME HYDROLOGI-Geological Survey, Reston, VA. Water Resources

W. G. Shope

W. U. Snope. IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 501-510, 3 fig, 8 ref.

Descriptors: \*Computers, \*Data storage and re-trieval, \*Hydrologic data collections, \*Information systems, \*Satellite technology, \*Telemetry, \*US Geological Survey, Automation, Computer pro-grams, Data processing, Data transmission, Hydro-metric stations, Information exchange, Information

The U.S. Geological Survey is utilizing a national network of more than 1000 satellite data collection stations, four satellite-relay direct-readout ground stations, and more than 50 computers linked together in a private telecommunications network to acquire, process, and distribute hydrological data in near real-time. The four Survey offices operat-ing a satellite direct-readout ground station pro-vide near real-time hydrological data to computers located in other Survey offices through the Sur-vey's Distributed Information System. The computer software that supports the national system for distributing near real-time data was developed from a prototype test that began operation in April 1985. The operational system that will be implemented in late 1986, provides redundancy, improved data handling, automated backup, performance monitoring, near real-time computations, graphics, and computer-generated alerts in case of communications, computer, or sensor failures or critical hydrological events. The computerized distribution system permits automated data processing and distribution to be carried out in a timely manner under the control and operation of the manner under the control and operation of the Survey office responsible for the data collection stations and for the dissemination of hydrological information to the water-data users. (See also W91-10103) (Author's abstract) W91-10148

NEW TECHNOLOGY FOR HYDROLOGICAL DATA ACQUISITION AND APPLICATIONS. Agricultural Research Service, Beltsville, MD. Hydrology Lab.

For primary bibliographic entry see Field 7B. W91-10149

MODELLING CLIMATIC CHANGE

NODELLING CLIMATIC CHANGE IN SOUTHERN AFRICA: A REVIEW OF AVAILABLE METHODS.
University of the Witwatersrand, Johannesburg (South Africa). Climatology Research Group. For primary bibliographic entry see Field 2B. W91-10182

GROUND-WATER RESOURCES AND SIMU-LATED EFFECTS OF WITHDRAWALS IN THE ST SHORE AREA OF GREAT SALT LAKE, UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-10262

METHOD OF INDEXING THE VARIABILITY OF ALPINE SEASONAL SNOW OVER LARGE

Otago Univ., Dunedin (New Zealand). Dept. of Geography.
For primary bibliographic entry see Field 2C.
W91-10351

SNOWMELT-RUNOFF SIMULATION MODEL OF A CENTRAL CHILE ANDEAN BASIN WITH RELEVANT OROGRAPHIC EFFECTS. Direccion General de Aguas, Santiago (Chile). For primary bibliographic entry see Field 2C.

W91-10353

UTILITY OF COMPUTER-PROCESSED NOAA IMAGERY FOR SNOW COVER MAPPING AN STREAMFLOW SIMULATION IN ALBERTA.

Alberta Environment, Edmonton. For primary bibliographic entry see Field 2C. W91-10354

MODELLING OF SNOWMELT DISTRIBU-TION FOR THE ESTIMATION OF BASIN-WIDE SNOWMELT USING SNOW COVERED

Tokyo Univ. (Japan). Dept. of Civil Engineering. For primary bibliographic entry see Field 2C. W91-10356

MODELLING THE EFFECTS OF AGROTECH-NICAL MEASURES ON SPRING RUNOFF AND WATER EROSION.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.

ary bibliographic entry see Field 2C. For primary W91-10359

SIMPLE SNOWPACK STRUCTURE MODEL AND ITS APPLICATION TO MOUNTAIN SNOWPACK PROBLEMS.

California State Univ.-San Bernadino. Dept. of Geography.

For primary bibliographic entry see Field 2C. W91-10361

ESTIMATING SNOWPACK PARAMETERS IN THE COLORADO RIVER BASIN.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2C. W91-10367

SNOW COVER PARAMETER RETRIEVAL FROM VARIOUS DATA SOURCES IN THE FEDERAL REPUBLIC OF GERMANY.

Cooperative Inst. for Research in Environmental Science, Boulder, CO. For primary bibliographic entry see Field 2C. W91-10368

INTEGRATION OF DIGITAL TERRAIN MODELS INTO GROUND BASED SNOW AND RUNOFF MEASUREMENT.

Saskatchewan Research Council, Saskatoon. For primary bibliographic entry see Field 2C. W91-10370

CLASSIFICATION MODEL OF SPATIAL ESTI-MATION OF SNOWPACK VARIABLES FROM SATELLITE DATA. Utah State Univ., Logan.

For primary bibliographic entry see Field 2C. W91-10371

DISTRIBUTION OF SNOW EXTENT AND DEPTH IN ALASKA AS DETERMINED FROM NIMBUS-7 SMMR MAPS (1982-83).

National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch. For primary bibliographic entry see Field 2C. W91-10372

ANALYSIS OF REMOTELY SENSED DATA. Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Mathatics and Statistics.

ematics and Statistics.
J. F. Wallace, and N. Campbell.
IN: Remote Sensing of Biosphere Functioning.
Ecological Studies 79. Springer-Verlag New York,
Inc., New York. 1990. p 291-304, 1 fig, 18 ref.

Descriptors: \*Data processing, \*Remote sensing, \*Satellite technology, Data interpretation, Mapping, Model studies.

Suitable data organization and analysis techniques are essential to the extraction of information from high-dimensional remotely sensed data. Data users face the problem of reduction of the data to useful face the problem of reduction of the data to useful numerical or pictorial summaries. Access is required to suitable candidate data sets and numerical processing methods to calculate and assess indicases or classifiers of the data. Where numerical estimates of processes are required on a continental estale, they should wait for the establishment by suitable analysis of optimal indices and error estimates. In any new application, it is appropriate initially to focus intensive analysis efforts on relatively small and well-known areas, examining possibly very complex data sets. Extension to broader very complex data sets. Extension to broader es may then be implemented. It is an implicit scates may their oe implemented. It is an implicit requirement of this process that research workers must have access to suitable statistical image proc-essing systems, and to data sets integrated over suitable spatial and temporal scales. (See also W91-10374) (White-Reimer-PTT) W91-10387

ATMOSPHERIC DISPERSAL OF POLLUT-ANTS AND THE MODELLING OF AIR POL-LUTION.

Warren Spring Lab., Stevenage (England). For primary bibliographic entry see Field 5B. W91-10415

QUANTITATIVE SYSTEMS METHODS IN THE EVALUATION OF ENVIRONMENTAL POLLUTION PROBLEMS.

Lancaster Univ. (England). Centre for Research on Environmental Systems. For primary bibliographic entry see Field 5B. W91-10425.

CHEMIGATION WITH LEPA CENTER

Texas Agricultural Extension Service, Texas A&M University, Amarillo, TX.
For primary bibliographic entry see Field 3F.
W91-10454

#### 8. ENGINEERING WORKS

#### 8A. Structures

NEW DESIGN OF WATER INTAKE WORKS FOR MOUNTAIN RIVERS. Y. A. Ibad-Zade, N. M. Mamedov, and A. M. Muslumov.

Musuumov. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 442-445, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 17-19, July 1990. 4 fig, 2 tab.

Descriptors: \*Hydraulic engineering, \*Hydraulic structures, \*Intakes, \*Irrigation design, \*Mountain streams, Abutments, Baffles, Caucasus, Construction, Discharge coefficient, Energy dissipation, Floods, Flow, Gates, Mudflows, Piers, Rivers, Sediments, Spillways, Stream discharge, Surface

The reconstruction of irrigation systems in the Great and Little Caucasus will require the construction of engineering headworks to provide continuous intake of water from mountain rivers. These rivers are characterized by rapidly occur-ring freshets, fluctuating discharges, abundant sedi-ments, destructive mud flows, and the almost com-plete cessation of surface runoff on some rivers in the summer. These factors hinder the construction of a water intake of the usual design, since individ-ual parts of the structure located in the channel limit the cross section of the flow and themselves are subject to its destructive action. Therefore, a new intake design was developed. A distinguishing feature of the new design is that the intake of water reature of the new design is that the intake of water is accomplished by changing the direction of flow by 180 deg against the flow of the river through piers and abutments. This permits sediment control and normal operating conditions of the intake with the use of an ogee spillway with a large discharge coefficient (m = 0.45-0.49). Dissipators in the form of baffle blocks are installed in the lower pool to

create normal water withdrawal and energy dissi-pation. Sediments are deposited in the receiving pation. Sediments are deposited in the receiving gate. Use of an oscillating gate makes it possible to withdraw the entire discharge of the river in the low-flow period and to regulate the withdrawal of water in the remaining period. (Doria-PTT)

PREDICTION OF THE CHANGE IN THE WATER LEVEL OF LAKE SAREZ AND CHARACTERISTICS OF SEEPAGE THROUGH THE

ACTERISTICS OF SELFAGE THROUGH THE USOI BARRIER.

E. G. Gladkov, V. S. Eletskii, and V. F. Zhabin.
Hydrotechnical Construction HYCOAR, Vol. 24,
No. 7, p 454-459, January 1991. Translated from Gidrotekhnicheskoe Stroitel July 1990. 4 fig, 3 tab, 2 ref.

Descriptors: \*Dams, \*Lake Sarez, \*Overflow, \*Rockslides, \*Seepage, \*Water level fluctuations, Avalanches, Estimating equations, Flood routing, Geology, Hydrologic budget, Lakes, Meteorology,

Lake Sarez (Tadzhik SSR) was formed in 1911 by Lake Sarez (Tadzhik SSR) was formed in 1911 by a rock avalanche that forms a barrier dam (Usoi barrier) rising 550 to 900 m above the river channel. The possibility of the lake spilling over the barrier was investigated. The change in lake level was predicted by assuming that seepage discharges predicted on the basis of hydrometeorological factors and the geological processes in the barrier will amount to only 80% of the average determined from the 1947-1986 seepage discharges curves. In this case, the seepage discharges with respect to the entire curve will be 1.25 times lower than the average. The change in level was calculated for the entire curve will be 1.25 times lower than the average. The change in level was calculated for the prediction by a formula for flood routing. The calculated volume of the lake was compared with observations. Maximum differences were 8% in 1916; in the other years of the period the deviations did not exceed 3%. Calculation confirmed the possibility of using the seepage discharge curves for predicting future water level fluctuations. The range of fluctuations for 1988, a very wet year, was taken for consideration of fluctuations. wet year, was taken for consideration of fluctua-tions within the year. The maximum level of that year exceeded the average annual by 5.6 m. The lowest point of the barrier has an elevation of 3,294.5 m. Based on present results, a flow of water over the barrier due to the inflow of water exceeding the outflow of the lake's water balance is impossible. (Doria-PTT) W91-09462

INVESTIGATION OF PILE ANCHORS FOR FLEXIBLE HYDROBIOTECHNICAL STRUC-

A. K. Bugrov, A. A. Stotsenko, and T. N. Korovnikova.

NOTOWINGVAI.

Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 460-465, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 29-32, July 1990. 3 fig., 9 ref.

Descriptors: \*Anchors, \*Aquaculture, \*Load testing, \*Materials engineering, \*Piles, \*Strength, Algae, Amur Bay, Coastal waters, Equilibrium, Floats, Mechanical engineering, Model studies, Soil compaction, Soil density.

Hydrobiotechnical structures (HBTs) are located near the coast at depths from 2 to 50 m, forming aquaculture plantations with an area of several hundred hectares. Flexible HBTs are composed of ropes maintained vertically by floats and weights and horizontally by anchors. Most failures of HBTs occur in the anchor system. Therefore, studies accessorability on the behavior of a nile results occur in the anchor system. Interfector, stud-ies were conducted on the behavior of a pile anchor under the effect of an extracting load and to investigate the effect of a cyclic load on the bearing capacity of the system. The main regulari-ties were determined to be rotation of the anchor under a load, compaction of the soil from the pressure of the anchor in the upper and lower zones, formation of gaps and their filling with loosened soil, and absence of a change in soil density in the middle zone over the height of the anchor. The horizontal movement of the anchor

#### Field 8—ENGINEERING WORKS

#### **Group 8A—Structures**

on the load is nonlinear. During cyclic loading separation occurs at loads greater than in the case of single loading. An engineering model was proposed for calculating the interaction of HBT pile anchors with a substrate. The limit load on the anchor under which extraction occurs is determined for the condition of exhibition of extraction. ancnor under which extraction occurs is determined from the condition of equilibrium of forces for the moment of separation with consideration of the deformed state of the anchor. The equation was used successfully in the design of HBTs for growing Gracilaria in Amur Bay (USSR). (Doria-PTT)
W91-09463

INVESTIGATION OF THE SEEPAGE REGIME IN THE FOUNDATION OF THE KAMA HYDROELECTRIC STATION ON A THREE-DI-

MENSIONAL MODEL.
For primary bibliographic entry see Field 8D.
W91-09466

ESTIMATING HOW EMBANKMENT DAMS BEHAVE DURING EARTHQUAKES, For primary bibliographic entry see Field 8D. W91-09796

SEISMIC RESPONSE OF A ROCKFILL DAM WITH AN ASPHALTIC CONCRETE CORE.

Norges Geotekniske Inst., Oslo.
T. Valstad, P. B. Selnes, F. Nadim, and B. Aspen.
International Water Power and Dam Construction
IWPCDM, Vol. 43, No. 4, p 22-27, April 1991. 9

Descriptors: \*Asphaltic concrete, \*Dam design, \*Dam stability, \*Earthquake engineering, \*Norway, \*Rockfill dams, Dam construction, Dam foundations, Earth dams, Earthquakes, Embank-ments, Seismic waves, Slope stability, Stability

The world's largest rockfill dam with an asphaltic concrete core is Storvatn, in southwest Norway. It is in an area of moderate seismic activity, where earthquakes of magnitude 5 are not uncommon. A eartnquakes of magnitude 5 are not uncommon. A study was conducted to evaluate the integrity of Storvatn dam under earthquake loading. Two levels of earthquake loading were considered: operational safe earthquake and maximum credible earthquake. Using the infinite slope method, the pseudo-static factors of safety for the submerged upstream and the dry downstream slopes can be evaluated in closed-form, by considering the equi-librium of a shallow mass of embankment in the direction parallel to the slope. Stability analyses were also carried out by the circular arc method. The variation of the factors of safety for the upstream and the downstream slopes as a function of stream and the downstream slopes as a function of the earthquake coefficient show that the down-stream slope satisfies the stability criterion (factor of safety > 1.15) with good margins for a magni-tude 6.5 earthquake; the upstream slope only just fails to satisfy this criterion. Should a dam like Storvath be constructed in an area of high seismic risk, the gradient of the outer slopes of the dam would have to be decreased to 1:1.85 upstream and 1:1.5 downstream to satisfy the stability criterion. The same core assembly (core and neighboring zones) could be used without any modifications. Maintaining a fine-grained material next to the core would, however, become more important as core would, nowever, become more important as the likelihood of core rupture increases. The main reasons for the favorable seismic behavior of a rockfill dam with an asphaltic concrete core are that the entire dam is built with materials that do not experience a significant reduction in strength during cyclic loading, and the dam can tolerate large permanent deformations along stip surfaces coing through the core without experiencing a going through the core without experiencing a sudden, uncontrolled release of the reservoir water. (Fish-PTT) W91-09797

CONTACT CLAY PROBLEMS DURING THE ERECTION OF MARU DAM.

National Committee on Large Dams, Bucharest

For primary bibliographic entry see Field 8D. W91-09798

ARGENTINA PLANS SECOND GENERATION OF RCC DAMS.
Instituto Cemento Portland Argentino, San Martin 1137, 1004 Buenos Aires, Argentina.
J. Buchas, and F. Buchas.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 4, p 33-38, April 1991. 7 fig, 2 tab, 6 ref.

Descriptors: \*Argentina, \*Concrete dams, \*Concrete technology, \*Dam construction, \*Dam design, Concretes, Materials testing, Portland cements, Reinforced concrete.

Following the completion in 1989 of the Uruguairolled concrete construction (RCC) dam in Argentina, eight further dams are being studied which could use RCC technology, because of its technical and economic advantages. All of the dams were originally planned as earth or rockfill embankments. At all these projects, steps are being taken to avoid difficulties which were encountered at Urugua-i, and, because of the close relationship between the design, construction process, and RCC quality, close attention is being given to studying the concrete mixes, including use of marginal materials which do not usually suit convenience. studying the concrete innes, including an agricultural suit conventional concrete specifications, such as by-products and high-range natural pozzolans. The two and high-range natural pozzolans. The two projects at an advanced stage of design are the Cuesta Blanca dam and the Chihuido II dam. With Cuesta Blanca dam and the Chihuido II dam. With RCC technology, it is possible to design the spill-way and dam to hold a smaller portion of the probable maximum flood and to be able to with-stand overtopping without resulting in failure, even during construction. For Cuesta Blanca, variations of the original design include the following options: changing the road and bridge from being over the dam; the possibility of hydropower production in addition to water supply and flood control; to work directly with a conveyor system to avoid delaws and quality reductions and to allow control; to work directly with a conveyor system to avoid delays and quality reductions and to allow higher production rates. At the Chihuido dam, an important testing program will be carried out with a wide variety of aggregate gradations and different cement contents, particularly a high-range of the naturally-available pozzolans to the mix. RCC is also being regarded as a solution for dam rehabilitation and enlargement of spillway discharge capacities at existing projects. (Fish-PTT) W91-09799

EARTHQUAKE STRESSES IN ARCH DAMS: I. THEORY AND ANTIPLANE EXCITATION. Energoprojekt, Belgrade (Yugoslavia). For primary bibliographic entry see Field 8E. W91-09806

EARTHQUAKE STRESSES IN ARCH DAMS: II. EXCITATION BY SV-, P-, AND RAYLEIGH

Energoprojekt, Belgrade (Yugoslavia). For primary bibliographic entry see Field 8E. W91-09807

INTERFERENCE OF KANATS AND WELLS. Colorado State Univ., Fort Collins. Dept. of Civil Engineering. For primary bibliographic entry see Field 4B.

DIVERSION STRUCTURE FOR PEAK FLOW REDUCTION.

Rivertech, Inc., Laguna Hills, CA. For primary bibliographic entry see Field 4A. W91-10047

INDIAN BEND WASH: THE INTEGRATION OF RECREATION, FLOOD CONTROL, AND LAND USE.

Erie and Associates, Phoenix, AZ. For primary bibliographic entry see Field 4A. W91-10054

SPILL: A DECISION SUPPORT SYSTEM FOR DESIGN AND EVALUATION OF SPILLWAYS.
Colorado Univ. at Boulder. Center for Advanced Decison Support for Water and Environmental Systems

Systems.
L. A. Garcia, and K. M. Strzepek.
IN: Computational Hydrology '87. Lighthouse Publications, Mission Viejo. 1987. p J14-J19. 1 fig, 2 tab, 7 ref.

Descriptors: \*Computer models, \*Decision making, \*Decision support systems, \*Design criteria, \*Design standards, \*Expert systems, \*Model studies, \*Spillways, Computer programs, Computers, Dams, Design storms, Hydrologic models, Rainfall-runoff relationships, Reservoirs, Routing,

Expert system technology has been applied to an evaluation of spillway design with a focus on the development of expert systems and their integration with an existing hydrologic model and interactive computer graphics. The composite system is referred to as SPILL and takes the user through a series of steps. Modeling of the catchment up-stream of the reservoir is the first stage, followed by the choice of an appropriate design storm from reservoir and dam characteristics. The next stage reservoir and dam characteristics. The next stage involves the acquisition of storm volume and distribution data, and routing the storm through the system. The final step involves the actual determination of an adequate spillway design based on the results of the previous steps. SPILL employs HYMO, a combined rainfall-runoff stream routing model as the hydrologic base of the system. The supporting errort systems were developed using model as the hydrologic base of the system. Ine supporting expert systems were developed using the RuleMaster building system. SPILL provides the user with the option to evaluate or design a proposed spillway. The system runs on a 2 floppy monochrome graphics IBM PC or compatible with 512K RAM. For full benefits, a hard disk, color graphics, and mouse is recommended. (See also W91-10018) (Author's abstract) W91-10057

APPLICATION OF A SIMPLE WEIR STRUCTURE FLOODFLOW BYPASS ANALYSIS PRO-

Williamson and Schmid, Irvine, CA For primary bibliographic entry see Field 7C. W91-10058

ENDOW USER'S GUIDE.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. For primary bibliographic entry see Field 7C. W91-10060

REMARKABLE HYDROLOGICAL WORKS OF THE AZTEC CIVILIZATION.

Mexico, Mexico, Mexico City. Water Resources Program.

J. A. Raynal-Villasenor.

J.A. Kaylaid-Vinaschot.

IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 3-9, 2 fig. 1 tab, 7 ref.

Descriptors: \*Archaeology, \*Aztecs, \*History, \*Hydraulic engineering, \*Mexico, \*Water use, Aqueducts, Conveyance structures, Dikes, Flood control, Flood protection, Water conveyance, Water users.

The Aztec civilization has been described as one of the most remarkable cultures in the world, not only because of its material achievements, but also because of its rapid evolution from a tribe of nomads to a highly sophisticated society which was able to produce beautiful pieces of poetry as well as complex urban developments. The Aztecs, well as complex urban developments. The Aziecs, in the beginning, built a city in the middle of a lake to protect themselves against their surrounding enemies. Among the remarkable pieces of engineering produced by the Aztec culture are their hydrological works. The Aztecs were able to build magnificent aqueducts as well as flood control works. The first aqueduct of the Aztec empire consisted of a twin pipe distribution system made in part of compacted soil and in part of wood for the crossings of the aqueduct over the bridges built to allow the passage of canoes. It was finished

#### Hydraulics-Group 8B

around 1466 AD, and its main purpose was to supply fresh water to the capital city. The water was conveyed through one pipe and when it got dirty, the water was diverted to the other pipe while the dirty one was cleaned and/or repaired. In spite of the original purpose that they served, roads played an important role as structural measures for flood control. With the construction of the first three roads, the fresh waters of the west and southwest parts of the valley were confined and southwest parts of the valley were confined and fishing was improved. However, a large flood in 1499 AD instigated the construction of the most important flood control work of the Aztec culture: a 16-km long by 20-m wide dike. This hydrologic structure had gates to control the flow of water from the lakes and to allow canoes to pass. A valuable lesson that the Aztecs present is that of integration in the environment: despite a hostile environment, they developed their culture in comintegration in the environment: despite a nostite environment, they developed their culture in com-plete harmony with the existing natural conditions, while maintaining the subtle equilibrium of the environmental conditions of the valley. (See also W91-10103) (Fish-PTT) W91-10104

### IRRIGATION WELL DESIGN AND CONSTRUCTION.

Texas Agricultural Experiment Station, College Station.

D. L. Reddell.

D. L. Redden.
IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 36-50. 5 fig, 4 tab.

Descriptors: \*Cost analysis, \*Economic evaluation, \*Irrigation wells, \*Pump wells, \*Pumping, \*Well costruction, \*Well design, Drilling, Irrigation operation, Well capacity, Well filters, Well function, Well pumping, Well screens, Well yield.

When drilling an irrigation well, the farmer should consider the ultimate or long-term well cost in-stead of the immediate or short-term cost. To phasize the importance of proper well design emphasize the importance of proper well design and construction, results from two case histories were reviewed. New well construction techniques at the two sites resulted in a much greater initial well cost, however, well yield at both locations was greatly improved. The new well constructions also resulted in more efficient wells. Well construction cost per gpm and annual pumping cost were significantly reduced using the new well construction techniques. In addition, the new wells pumpend free water, and the expected well life upser tion techniques. In addition, the new wells pump sand-free water and the expected well life was increased from 10 to more than 25 years. The two main parameters used to describe the effects of improved well drilling and construction procedures are specific capacity and well efficiency. The procedure for and important considerations for constructing wells includes the test hole, electric log. sieve analysis, the well screen, gravel pack. constructing wells includes the test hole, electric log, sieve analysis, the well screen, gravel pack, well drilling methods, well diameter, and drilling muds. Drilling wells has become more involved than it was 30 to 50 years ago. It is imperative that new procedures such as swabbing, jetting, use of creative drilling, mude and sieve analyses he utilized. ic drilling muds and sieve analyses be utilized to produce the most water for each dollar invested. When these techniques are utilized, one can expect when these techniques are utilized, one can expect to get larger well yields, smaller water level drawdowns, sand-free water, longer pump life and longer well life. These techniques are no longer experimental, but are commercially available today. (See also W91-10445) (VerNooy-PTT) W91-10449

### ECONOMICS ALTERNATIVES TO DITCH TRANSPORTATION OF WATER.

For primary bibliographic entry see Field 3F. W91-10456

#### 8B. Hydraulics

### BACKWATER CURVES IN CIRCULAR CHAN-

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Hydrologie und Glaziologie. Wasserb

For primary bibliographic entry see Field 2E.

W91-09392

#### INTERACTIVE COMPUTER-AIDED DESIGN OF INVERTED SIPHONS. California Univ., Davis. Dept. of Civil Engineer-

Shrestha, and J. J. DeVries.

Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 117, No. 2, p 233-254, March/April 1991. 5 fig, 3 tab, 12 ref, 3 append.

Descriptors: \*Canals, \*Computer-aided design, \*Inverted siphons, Channel slow, Computer programs, Conduits, Darcy-Weisbach equation, Design criteria, Downstream, Drainage systems, Flow velocity, Head loss, Hydraulic parameters, Sediment transport, Siphons, Suspended sediments.

A typical application of siphons is for the convey-ance of canal flows across drains, rivers, or roads. The question of whether an inverted siphon is required is decided by actual site investigations and economic considerations. An interactive computer program was written in FORTRAN for the design of inverted siphon conduits. Determination of the head loss through the siphon is the primary design consideration, with the head loss, in turn, a function of hydraulic and geometric parameters: pipe size determined by a maximum permissible velocity in the pipe; the hydraulic control; the type of transitions at the inlet and outlet, and the transition hydraulics; the entrance and exit loss; the loss due to bends; the friction loss due to clear water only; and, the friction loss due to the presence of sedi-ment in the water. In addition to the basic hydraulic processes involved in the design process, the program takes into consideration the head loss due to sediment transport, upstream and downstream protection, and seepage analysis. Determination of head loss for siphons carrying small amounts of nead loss for sipnons carrying small amounts or sediment can be approximated by using the Man-ning or the Darcy-Weisbach equation (with a factor of safety) without significant error. For con-ditions of flow with sediment in relatively long siphons, the head loss values will be considerably hisber, and their estimation by either the Manning higher, and their estimation by either the Manning equation or the Darcy-Weisbach equation will produce large errors that could be detrimental to the operation of the structure. (Brunone-PTT) W91-09396

#### CHANNEL-FORMING EFFECT OF FLOODS AND FRESHETS.

For primary bibliographic entry see Field 2J. W91-09456

# CALCULATION OF A HYDRAULIC JUMP ON THE BASIS OF A HYBRID MODEL. L. I. Vysotskii, A. B. Denisov, and B. I. Yudin. Hydrotechnical Construction HYCOAR, Vol. 24,

No. 7, p 434-436, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 12-13,

Descriptors: \*Hydraulic jump, \*Hydraulic struc-tures, \*Stilling basins, Flow, Hydroelectric plants, Mathematical equations, Mathematical studies,

A method was developed for calculating the flow in a radially expanding hydraulic jump and an expanding stilling basin with a special inlet part with a bottom of double curvature. The method is based on the numerical solution of an integrodifferential equation of the distribution of pressure in flows curved in the vertical plane, equation of continuity, and Bernoulli equation. The model contains no assumptions about a hydrostatic pressure distribution. The experience of calculating flows in a hydraulic jump within the frameworks of the jet model of a flow confirmed its efficacy. The method enables calculation of the designs of the transition of nonsymmetric and curvilinear chutes with stilling basins. An analytical solution for the with stilling basins. An analytical solution for the coordinates of the free surface was obtained for the transition stretch with a flow radial on the basis of solving a partial differential equation of the free surface. For this case, the horizontal lines of the free surface are represented by arcs of concentric circles. An expanding stilling basin with a special

inlet was calculated during alternative designing of the transition of the pools of the Ishtugan hydro development (USSR). The proposed design of the stilling basin makes it possible to reduce the amount of construction and assembly work. (Doria-PTT)

#### TRANSIENT PROCESSES IN CANALS WITH PUMPING STATIONS.

A. B. Maslov, and N. R. Ablyazov. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 437-441, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 14-17, July 1990. 3 fig, 3 ref.

Descriptors: \*Hydraulic models, \*Irrigation canals, \*Open-channel flow, \*Pumping plants, Canals, Computer models, Mathematical models, Soviet Union, Water level fluctuations, Wave propagation, Wave velocity, Waves.

The All-Union State Planning, Surveying, and Scientific Research Institute of Water Management Construction of the USSR created a specialized experimental complex for hydraulic investigations of canals with pumping stations in various operat-ing regimes. The experimental complex represents a model of a canal with two pumping stations at the ends. The length of the canal is 25.8 m. The experimental investigations of the dynamic proc-esses in the model canal and structures of the pumping stations were carried out by direct recordings of water level fluctuations. Investigations of transient processes in the canal were carried out in two different schemes of water motion. Results of calculations were compared with data from experimental investigations. The results of numerimodeling of transient processes by the methods of Churmaev and Rozhanskii were close to the experimental data. Churmaev's model also describes wave phenomen of the water surface with consideration of forward and reverse waves. The consideration or forward and reverse waves. In emplitude of oscillations, wave propagation velocity, and damping time correspond to the actual. It is concluded that changes in the operating regimes of pumping stations substantially affect dynamic processes in irrigation canals and lead to intense fluctuations of the levels and discharges. Transient processes in the pools of canals correspond to the results of numerical calculations on a computer and agree with mathematical models. (Doria-PTT) W91-09458

#### HYDRAULIC RESISTANCE OF RIDGE TURBID CHANNEL FLOWS.

B. K. Balakaev, and A. N. Lyapin. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 446-450, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 20-22, July 1990. 3 fig, 2 tab, 9 ref.

Descriptors: \*Channel flow, \*Channel morphology, \*Resistance, \*Sand, \*Turbidity, \*Turbulent flow, Bottom sediments, Boundaries, Flow, Froude number, Mahematical equations, Saturation, Suspended sediments.

Energy losses in flatland rivers with clarified water Energy losses in flatland rivers with clarified water due to the resistance of sand ridges amount to 90% of total losses along the length. Relations making it possible to determine the resistance of channel flows as applied to prototype and laboratory conditions were obtained from an analysis of nongradual variability of a channel flow and wave equations corresponding to them. Studies of the effect of turbidity of a turbulent flow on the size of sand ridges formed by them confirmed the interrelationship of the frequency characteristics of the flow, turbidity, and form of the ridges. The heights of the ridges first increase as a function of turbidity, reach a maximum height upon saturation of the flow with suspended sediments of 3 kg/cu m, and then sharply decrease. The lengths of the ridges at first decrease, reach a minimum value for this same saturation of the flow, and then sharply increase. The concentration of suspended and bottom particles increases noticeably in the lower layers of the flow, especially at a distance from the bottom less than 1/4 the depth of the flow. Therefore, the

#### Field 8—ENGINEERING WORKS

#### Group 8B—Hydraulics

boundary of the difference of densities is located near this depth and the lower layer is able to display oscillation properties. (Doria-PTT)

#### DECREASE OF LONGITUDINAL AXIAL VE-LOCITIES OF AERATED JETS.

V. A. Maglakelidze.

Nydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 450-453, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 22-24, July 1990. 3 fig. 16 ref.

Descriptors: \*Aeration, \*Hydraulics, \*Jets, \*Velocity, Dredging, Flow measurement, Hydraulic structures, Nozzles, Propellers, Scour, Tubes, Valves, Venturi meters, Water level.

An experimental device was used to study the results of a decrease in the longitudinal axial ve-locities of aerated jets. The device uses a compressor to feed air into a mixing chamber; the air flow rate is varied by a regulator and is measured by a flowmeter. The air-water mixture passes through a submerged nozzle into a water tank and is spread by an aerated jet. The local mean velocities along the axis of the jet are measured by a specially designed double Pitot-type tube. Vertical movement of the tube is provided by a rotating handle. The velocity tubes are connected to a mercury manometer. The water flow rate is regulated by a valve and is measured by a Venturi flowmeter. The experimental jets are aerated and not free. On the basis of the laboratory experiments, a formula of the decrease of the relative axial longitudinal velocities in water-air jets spreading beneath the water level as a function of the air content in their initial section was derived. The length of the initial section of the jet changes considerably depressions of hydraulic structures. (Doria-PTT)

#### CRITERION OF WAVE BREAKING ON A SHORE SLOPE IN THE PRESENCE OF AN OPPOSING CURRENT.

I. G. Kantarzhi, and M. A. Lumel'skaya. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 470-474, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 36-38, July 1990. 3 fig, 1 tab, 5 ref.

Descriptors: \*Shores, \*Slopes, \*Water currents, \*Wave action, \*Wave height, Computers, Energy, Estimating equations, Flow rates, Flow velocity, Mattheway Computers, Shalls Shalls Shalls Shalls Shalls Shalls Shalls Shalls Mathematical analysis, Shallow water, Streams,

Experiments were conducted to construct a practi-cal criterion for determining wave breaking on a cal criterion for determining wave breaking on a shore slope with an opposing current. The charac-ter of breaking of the waves both on the slope without the current and with the current was of the plunging breaker type; in the presence of the current the length of the foam region somewhat increased. The agreement between measured and calculated values of the height of waves along the breaker line with a current confirms the practical breaker line with a current confirms the practical use of a modified Goda's criterion for wave breakuse of a modified Goda's certerion for wave break-ing. To estimate the depth and height of the waves on breaking, a second relationship was obtained from the energy conservation law for waves on a slope with a current. The simultaneous solution of two equations for known depth and wave height upon breaking without a current makes it possible to determine the depth and wave height upon breaking with a current. These two equations are solved simultaneously by the method of successive approximations, which is easily realized on a computer. If the stream emptying into a water body is sufficiently wide and the distribution of the flow rate over the width is known, the position of the front of the breaking wave on a current can be estimated by the method. The method will also give satisfactory results with a more complex vertical distribution of current velocity, since at the site of breaking, where the shallow-water approximation holds, the form of the vertical current profile weakly affects the transformation of waves by the current. (Doria-PTT) W91-09465

ALLUVIAL RIVER BED TRANSPORT PROC-

ESS WITH GRADED MATERIAL.
California Univ., Berkeley.
For primary bibliographic entry see Field 2J.
W91-09472

DEBRIS BASIN POLICY AND DESIGN.

Maryland Univ., College Park. Dept. of Civil Engineering. For primary bibliographic entry see Field 2J. W91-09782

#### MODELING ALLUVIAL-CHANNEL FLOW BY MULTIMODE CHARACTERISTICS METHOD.

Geological Survey, Reston, VA. C. Lai

Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 117, No. 1, p 32-53, January 1991.

Descriptors: \*Alluvial channels, \*Flow models, \*Fluidized bed process, \*Model studies, \*Openchannel flow, \*Sediment transport, \*Simulation analysis, Algorithms, Channel flow, Flow equations, Fluidized beds, Mathematical studies, Numerical analysis, River beds, Streamflow, Suspended sediments, Unsteady flow.

Unsteady flows in movable-bed open channels can be described by a set of three partial differential equations: the equations of continuity and motion for sediment-laden flow and the equation of continuity for sediment. It is possible to develop a genuinely coupled flow simulation model by solving the three equations simultaneously. The equations are first transformed into a set of characteris-tic equations that are organized for numerical soluby the method of characteristics (MOC). However, the characteristic values representing water-wave and bed-deformation propagation have great disparity in this class of unsteady-flow models; this poses significant difficulty in model treatment. A multimode numerical scheme has been developed to be particularly suitable for treatment and intensity heaves of its builties. ing such disparity because of its ability to apply automatically a most appropriate computational mode to each type of characteristic. With this new scheme, mathematically-effective and physically-sensitive coupling can be attained. Theoretical con-siderations, mathematical derivations, and algorithm formulation that lead to, and guide, the development of a basic simulation model have been developed. The numerical model based on the formulated algorithm has been tested successfully using actual hydraulic data from a river reach combined with some designed sediment data. (Author's abstract)

#### VORTICES IN HYDRAULICS.

Universidad National Autonoma de Mexico, Cactus 14A, Pedregal De Las Fuentes, 62550 Jiu-E. Levi.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 399-413, April 1991. 12 fig, 13 ref.

Descriptors: \*Hydraulic engineering, \*Hydraulic properties, \*Hydraulics, \*Vortices, Hydraulic structures, Intakes, Jets, Structural engineering, Turbidity currents, Water currents.

In 40 years of theoretical and experimental rein 40 years of theoretical and experimental re-search concerning the inception, development, and damaging action of vortices, it has been found that a vertical vortex is normally formed in an unstable environment, in the presence of a diverging or converging flat jet that subsequently feeds it by momentum transfer. A tentative explanation of the intermittency of swirls at intakes was obtained proving the theoretical viability of vortices whose intensity varies more or less periodically along their axes. The inspection of intermittent vortices that develop spontaneously behind a weir or under a sluice gate led to the establishment of a universal Strouhal law, able to predict the frequency of the oscillations that can be excited within a restrained fluid body by a free current flowing along it, and, as a consequence, the frequency of vortex shed-ding and the structural vibrations that this phe-

nomenon may induce. Applications that define the causes of revetment damages in hydraulic struc-tures were made successfully. (Author's abstract)

#### ENTRAINMENT OF BED SEDIMENT INTO SUSPENSION

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering. For primary bibliographic entry see Field 2J. W91-09809

## BED SHEAR STRESS AND SCOUR OVER BED-TYPE RIVER INTAKE. Grampian Regional Council, Aberdeen (Scotland).

of Water Services.

A. G. Maclean. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 436-451, April 1991. 5 fig, 2 tab, 13 ref.

Descriptors: \*Channel scour, \*Intakes, \*River beds, \*Scour, \*Shear stress, Bottom currents, Channel flow, Hydraulic engineering, Sediment transport.

The bed-type river intake consists of a chamber containing a gravel filter set in the bed of the river through which water is abstracted downward. The slow-moving water at the bottom of the river is removed, bringing the faster-moving layers above into contact with the bed, causing an increase in the bed shear stress at the intake. Laboratory experiments were carried out to determine the in-crease in bed shear stress and local scour over the zone of suction associated with a bed-type river intake in a channel with a mobile bed. Bed shear stress was estimated first by observing the move-ment of indicator grains whose threshold shear stress in uniform flow was already known, and second by observing the rate at which local scour takes place. Evaluation of the two sets of results indicates that, at the onset of scour when particles are lifted from the bed by increased bed shear stress, they do not strike the bed again until they are clear of the scour zone. The final scour depth was found to be directly proportional to the differ-ence between the initial bed shear stress because of suction and the threshold bed shear stress for the bed grains in the presence of suction. (Author's W91-09810

## PREDICTION OF MAXIMUM SCOUR DEPTH AT SUBMARINE PIPELINES, Nanyang Technological Inst., Singapore. School

of Civil and Structural Engineering. Y. M. Chiew.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 452-466, April 1991. 7 fig, 2 tab, 25 ref.

Descriptors: \*Channel scour, \*Pipelines, \*Scour, \*Wave action, Bottom currents, Estimating equations, Hydraulic engineering, Sediment erosion, Shear stress, Water currents.

Interactions between submarine pipelines and an erodible bed under current and/or wave conditions tend to cause scouring around the pipelines. At present, several empirical methods, based on vari-ous research findings, can be found in the literature for estimating the equilibrium scour depth under unidirectional current. A review has been made of published results relating to local scour around submarine pipelines, highlighting the limitations of existing methods for estimating scour depth at the pipeline. Based on experimental results, an empirical function has been proposed relating the amount of gap flow through the scour hole for given flow conditions. With the aid of this function, it is possible to predict the maximum scour depth at submarine pipelines for given flow and geometric boundary conditions. Published results suggest that the maximum equilibrium sour depth occurs when the pipeline is just lying on a plane bed and sub-jected to a pure unidirectional current. The undis-turbed bed shear stress is equal to the critical shear stress for sediment entrainment. This condition im-

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plies that there is no general sediment transport away from the pipeline. The predicted maximum scour depth using the iterative method proposed compares well with experimental results. (Author's abstract) W91-09811

KINEMATIC WAVE CONTROVERSY. San Diego State Univ., CA. Dept. of Civil Engi-

neering. V. M. Ponce. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 4, p 511-525, April 1991.

Descriptors: \*Diffusion coefficient, \*Kinematic wave theory, \*Numerical analysis, \*Rainfall-runoff relationships, Channel flow, Hydraulic engineer-ing, Hydrologic models, Model studies, Small wa-

There is a continuing controversy regarding the nature and applicability of the kinematic wave theory. Kinematic and diffusion waves were reviewed to help focus the attention of future reviewed to help focus the attention of future re-searchers and practitioners so that the controversy may be brought to a timely end. Kinematic waves have been shown to be nondiffusive, but to under-go change in shape due to nonlinearity. This latter feature gives kinematic waves the capability of steepening, eventually leading to the formation of the kinematic shock. Kinematic wave solutions using finite differences have been shown to possess intrinsic amounts of numerical diffusion and disperintrinsic amounts of numerical diffusion and dispersion. These numerical effects are artificial and tend to disappear as the grid size is refined, making the solution dependent on the choice of grid size. Kinematic wave theory can be improved by extending it to the realm of diffusion waves. In this way, the diffusion inherent in many practical runoff computations can be accounted for directly in the modeling, rather than as an afterthought. The use of a kinematic wave method is indicated for small catchments, in cases where it is possible to resolve the physical detail without compromis-ing the deterministic nature of the model. Conversely, the unit hydrograph is advocated for mid-size catchments, where the kinematic wave method may prove difficult to implement. The dynamic extension to kinematic and diffusion models shows promise, particularly for modeling channel and flow conditions in which the Vedernikov number is substantially different from zero.
(Author's abstract)
W91-09814

UNIFORM AERATED CHUTE FLOW.

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt füer Wasserbau, Hydrologie und Glaziologie.

Nythologia W. H. Hager.

Journal of Hydraulic Engineering (ASCE)

JHEND8, Vol. 117, No. 4, p 528-533, April 1991. 4 fig, 5 ref.

Descriptors: \*Air entrainment, \*Chutes, \*Hydrau-lic structures, \*Instream aeration, \*Open-channel flow, \*Uniform flow, Channel flow, Channel morphology, Cross-sections, Flow characteristics, Hydraulic engineering, Hydraulic roughness, Water

Self-aerated flow in chutes may be subdivided into an approach zone, a gradually-varied aerated flow zone, and a uniform aerated flow zone. The uni-form aerated flow zone may be described by the mixture flow depth relative to some air concentra-tion, the air-concentration profile, the velocity pro-file, and the average cross-sectional air concentra-tion. Scaling quantities are related to pure water flow, involving water depth and water velocities, and depend exclusively on the chute shape, the chute bottom slope, and the wall roughness. The air-concentration profile was analyzed for a wide rectangular, channel of definitive wall roughness. mixture flow depth relative to some air concentrarectangular channel of definitive wall roughness.

Then the average air concentration was deter-Then the average air concentration was determined as a function of chute slope. A significant increase of the average cross-sectional air concentration with the chute slope was observed. The uniform aerated flow depth at 99% air concentration was considered. For wide rectangular chan-

nels, the ratio of mixture to clear water depth depends mainly on the chute slope, moderately on the roughness coefficient, and only slightly on the clear water depth. The result was compared to a proposition in which the effect of roughness is contained, and it was found that, interestingly, the effect of chute slope was identical for both mixture depths based on 90% and 99% air concentration. (Fish.PTC) (Fish-PTT) W91-09815

TURBULENT MIXING AT FRESHWATER/ SALTWATER INTERFACES. California Inst. of Tech., Pasadena. For primary bibliographic entry see Field 2L. W91-09859

NWS DAMBREAK OR NWS SIMPLIFIED DAM

Missouri Univ.-Rolla. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C. W91-10050

SPILL: A DECISION SUPPORT SYSTEM FOR DESIGN AND EVALUATION OF SPILLWAYS. Colorado Univ. at Boulder. Center for Advanced Decison Support for Water and Environmental

For primary bibliographic entry see Field 8A. W91-10057

APPLICATION OF A SIMPLE WEIR STRUCTURE FLOODFLOW BYPASS ANALYSIS PRO-

GRAM.
Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 7C.
W91-10058

#### 8C. Hydraulic Machinery

SELECTION OF THE METHOD OF REGU-MICROHYDROELECTRIC TIONS WITH AN AUTOBALLAST LOAD.

B. V. Lukutin, and S. G. Obukhov. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 466-470, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 33-35, July 1990. 3 fig, 4 ref.

Descriptors: \*Ballast, \*Electrical engineering, \*Electrical equipment, \*Hydroelectric plants, Optimization, Turbines.

Autoballast systems are becoming widespread for stabilizing the operating regime of microhydroe-lectric stations. Optimization of the parameters of the autoballast system requires a systems approach with consideration of all elements of the microhydroeletric system (microHES) turbine, generator, electrical load, and stabilization devices. As a result of investigations, it is concluded that both the stability of operation in steady regimes and dynamic properties depend on the method of regu-lating the ballast load of a microHES. A compariisting the banast road of a microries. A comparison of the two main types of autoballast system (current and frequency) shows that both provide a sufficiently high quality of stabilization of the output voltage of a microHES. The current system has better dynamic properties. Consequently, it can be recommended for plants operating on an unsteady load with frequent connection and disconnection of consumers, including motors of commensurate power. However, it is necessary to bear in mind that the current system provides automatic compensation of variations of only one disturbing effect of the powerplant: its electrical load. The speed scheme provides better stabilization of the output voltage in static regimes and makes it possible to compensate automatically for variations of not only the load but also the energy of the work-ing flow of water arriving at the turbine. (Doria-PTT) W91-09464

WATER-PUMPING DEVICES: A HANDBOOK FOR USERS AND CHOOSERS.

IT Power Ltd., Eversley (England). P. Fraenkel.

Intermediate Technology Publications, London.

Descriptors: \*Handbooks, \*Hydraulic equipment, \*Irrigation, \*Pumps, Costs, Economic aspects, Energy, Hydraulic machinery, Hydroelectric power, Irrigation practices.

Small holdings can be the source of a significant proportion of a community's--and a country's--food production, and they can also be more pro-ductive and more energy efficient than large hold-ings. Efficient and effective irrigation of these lands can, therefore, have a dramatic effect on lands can, therefore, have a dramatic effect on agricultural output; at the heart of irrigation lies the problem of lifting or pumping water. This handbook surveys the water lifting technologies which are available and appropriate for small holdings-defined as areas up to 25 ha (60 acres)-and produces detailed guidance on the suitability of different methods of water lifting in different situations. Human-power and animal-power; internal and external combustion systems electrical wind and external combustion systems; electrical, wind, solar and hydropower; and the uses of biomass and coal, are surveyed in detail in relation to mechanical capability as well as costs, reliability and availability. (Lantz-PTT) W91-10062

EFFECT OF OPERATING PRESSURE AND IR-RIGATION EFFICIENCY ON PUMPING

Texas A and M Univ., College Station. Dept. of Agricultural Engineering. G. Fipps.

IN: Proceedings of: South Texas Irrigation Conference, January 15, 1991, Hondo, Texas. Texas Agricultural Extension Service, College Station. 1991. p 51-60. 2 fig. 6 tab, 11 ref.

Descriptors: \*Agricultural water, \*Cost analysis, Descriptors: "Agricultural water, "Cost analysis, "Economic evaluation, "Energy costs, "Ground-water costs, "Irrigation efficiency, "Irrigation wells, "Operating costs, "Pumping head, Economic ic efficiency, Fuel, Irrigation practices, Pressure head, Pumping plants, Sprinkler irrigation, Sprin-klers, Water use efficiency.

Pumping costs are often one of the largest single expenses in irrigated agriculture. The factors that affect the costs of pumping water for irrigation include irrigation efficiency, pumping plant efficiency, prosepower requirements and fuel requirements. The major focus was upon the influence of ments. The major rocus was upon the inneance or operating pressure and irrigation efficiency on fuel usage and costs. As an example, a center pivot irrigation system with a diesel-powered pumping plant was studied. Calculations are shown for total dynamic head, water horsepower, annual fuel use, fuel costs, total water pumped per year, and annual water applied to the crop. It was shown that by water applied to the crop. It was shown that by reducing operating pressures using low pressure drop nozzles or low energy precision application sprinklers (LEPA) and by improving irrigation efficiency, pumping time could be reduced while supplying the crop with the same amount of water. This would result in a reduction of the total yearly fuel bill. For the system studied, \$9774 or \$13,237 per year (out of \$23,260) in fuel costs could be reach by convertised to low pressure drop or 250. saved by converting to low pressure drop nozzles, or LEPA, respectively. (See also W91-10445) (VerNooy-PTT) W91-10450

#### 8D. Soil Mechanics

INVESTIGATION OF THE SEEPAGE REGIME IN THE FOUNDATION OF THE KAMA HYDROELECTRIC STATION ON A THREE-DIMENSIONAL MODEL.

A. O. Shestopal, A. A. Sinyavskaya, and V. V. Kushlin.

Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 475-479, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 39-42, July 1990. 6 fig, 2 ref.

#### Field 8—ENGINEERING WORKS

#### **Group 8D—Soil Mechanics**

Descriptors: \*Foundation failure, \*Hydraulic engineering, \*Hydroelectric plants, \*Perm, \*Seepage, Clays, Downstream, Drainage, Groundwater, Grouting, Gypsum, Piezometers, Sand, Soil horizons, Subsurface water, Upstream.

The Kama hydrostation upstream of Perm (USSR) was constructed on a foundation of gypsum layers subject to dissolution. A three-dimensional model of the foundation was used to study the effect of vertical drainage on the movement of subsurface waters. This model does not reflect a turn of the groundwater contours toward the right bank. Leakage between the sand-clay horizon and the next lower, gypsum-containing, horizon, without drainage, was characterized as follows: Under the upstream apron fresh water moves downward at a rate of 61 cu m/d; under the powerhouse the water moves upward at a rate of 462 cu m/d; and under the downstream apron 590 cu m/d. After connecting the vertical drainage, the inflow of fresh water under the upstream apron downward increased by a factor of 10 and was 628 cu m/d, and upward nt of water decreased and was 235 cu m/d under the powerhouse and 340 cu m/d under the downstream apron. Results support the decision to disconnect the vertical drainage. It is also concluded that serious hydrogeological investigations are needed to explain the cause of the anomalously low heads of groundwaters on the right bank (lower than in the lower pool). Results of piezometric observations indicate the ineffectiveness of the grout curtain; grouting works should continue. (Doria-PTT) W91-09466

SEEPAGE INVESTIGATION. Engineering Associates, Madison, WI.
For primary bibliographic entry see Field 8G.
W91-09771

### ESTIMATING HOW EMBANKMENT DAMS BEHAVE DURING EARTHOUAKES.

W. D. L. Finn.
International Water Power and Dam Construction
IWPCDM, Vol. 43, No. 4, p 17-22, April 1991. 15

Descriptors: \*Dam stability, \*Earth dams, \*Earth-Descriptors: "Data stability, "Earth dams, "Earth-quake engineering, "Stress analysis, Computer pro-grams, Dam foundations, Deformation, Earth-quakes, Earthworks, Interstitial water, Liquefac-tion, Mississippi, New Guinea, Pore pressure, Seis-mic waves, Slope stability, Soil properties, Stress-strain curves."

Earthquakes pose two major challenges to geotechnical engineers concerned with embankment dams: one is the design and construction of safe dams; the other is the assessment of the safety of existing dams, especially those with zones of po-tentially liquefiable materials in the embankment itself or in the foundation. The dynamic response of an earth dam is usually computed in engineering practice using an equivalent linear (EQL) method of two-dimensional (2-D) analysis, which may be approximately corrected for 3-D effects, but which cannot take into account the effects of seismicallyinduced porewater pressures or predict the perma-nent deformations directly. A nonlinear dynamic effective stress method of analysis has been devel-oped, which takes into account the effects of seisopen, which takes into account the elected of sets included porewater pressures, and calculates permanent deformations directly, using the computer program TARA-3, and TARA-3FL which adds a liquefaction failure factor. Not only are important indices of the behavior of a dam during an earthquake provided, such as loss of freeboard, but the internal stress-strain conditions in the different zones of the dam are also available. The usefulness of this information has been illus-Ine usefulness of this information has been illustrated by the analysis of Lukwi dam in New Guinea (showing a highly nonlinear response of the foundation to strong shaking). Deformation analysis of earth structures with liquefied zones is a very useful complement to conventional slope stability analysis for studying the effects of liquefactions and deciminate of foreign statement. tion, and designing cost-effective remedial measures, as was shown in the case of the Sardis dam in Mississippi. Analysis of post-liquefaction deforma-tions must cope with large changes in strength and

stiffness of the soils when liquefaction is triggered; it is imperative that the stability of any computed deformed section be checked by a conventional stability analysis. The kinds of analyses exemplified by TARA-3 and TARA-3FL are well within cur-rent practical and computational capability. (Fish-PTT) W91-09796

CONTACT CLAY PROBLEMS DURING THE ERECTION OF MARU DAM.

National Committee on Large Dams, Bucharest (Romania)

(Romana).

D. Stematiu, R. Popescu, and E. Luca.

International Water Power and Dam Construction

IWPCDM, Vol. 43, No. 4, p 28-33, April 1991. 7 fig. 1 tab. 4 ref.

Descriptors: \*Clays, \*Dam construction, \*Dam stability, \*Earthworks, \*Rockfill dams, \*Romania, Clay soils, Dam foundations, Earth dams, Finite element method, Maru Dam, Numerical analysis, Plasticity, Soil moisture deficiency, Stress analysis.

Maru dam (Romania) is a rockfill dam with a central clay core, and is now in the final stages of construction. The interface between the clay core and the foundation rock is a zone of clay of high plasticity (contact clay), which is capable of high plasticity (contact clay), which is capable of accommodating the core settlements without any fissuring risk, especially in the case of the steep right abutment slopes. According to the technical specifications, the increased plasticity required the clay compaction to take place at a specified moisture content. However, during an unusually hot and dry summer in 1988, the specifications regarding the contact clay moisture content were not met. Several alternatives were proposed for remedial measures, such as replacement of the fill in the vicinity of the abutments with better clay, grouting with fluid bentonite in the contact zone, placement with fluid bentonite in the contact zone, placement of cut-off bentonite walls on the affected abut-ments, or rescheduling of the reservoir filling to compensate for the moisture deficiency. A numericompensate for the mosture denticency. A numerical simulation (finite element modeling) was performed to show the potential consequences of the clay layer being too dry. The settlement contour had a normal pattern, with maximum values in the mid-third of the dam. The comparison between the slippages and the tangential stresses at the contact pointed to disturbances produced by the performance conditions: the real tangential displacements in the proximity of the right abutment given by the lower moisture content of the contact clay were 5 to 6 times smaller than the normal ones, and the tangential stresses acting at the contact point in the same zone were twice as great on the right abutment and 1.5 times greater on the left abutment. Based on the results, it was decided to continue the passed on the results, it was decided to continue the fill placement with special provisions for dam sur-veillance, and special conditions for reservoir im-poundment. (Fish-PTT) W91-09798

#### 8E. Rock Mechanics and Geology

EARTHQUAKE STRESSES IN ARCH DAMS: I.

THEORY AND ANTIPLANE EXCITATION.
Energoprojekt, Belgrade (Yugoslavia).
S. B. Kojic, and M. D. Trifunac.
Journal of Engineering Mechanics (ASCE)
JENMDT, Vol. 117, No. 3, p 532-552, March
1991. 9 fig, 26 ref.

Descriptors: \*Arch dams, \*Dam stability, \*Earth-quake engineering, \*Seismic waves, \*Stress analy-sis, Canyons, Dam foundations, Earthquakes, Finite element method.

In the past, little attention has been devoted to the effects of traveling seismic wave excitation of canyon walls that support arch dams. A procedure has been developed for analysis of earthquake response of concrete arch dams to nonuniform motion of the canyon walls, based on the finite element method for the linear response. It was shown that the total response can be described by the dynamic and quasi-static responses and that the forcing vector can be specified in terms of the free-

field motion of canyon walls by solving the two-dimensional wave equation. The transient, up-stream-downstream (antiplane) motions of the canyon walls induced by plane SH-waves was determined. The response of an idealized arch dam was investigated neglecting the dam-canyon inter-action, and the effects caused by the wave propa-gation across the canyon. It was found that the nonuniform, antiplane, free-field motion of the canyon walls depends on the size and shape of the canyon; from point to point along the canyon walls, the motion changes its amplitudes and phases, depending on the incidence angle and the frequency of the arriving waves. The dam re-sponse to the uniform canyon motion consisted mostly of the lower symmetric modes of vibration, resulting in symmetric distribution of the normal stresses. The dam response to the nonuniform canyon accelerations decreases by about 25-30% with respect to the case of excitation by the uni-form canyon motion. The dynamic stresses decrease while the quasi-static response increases as the direction of incidence approaches the horizontal. The quasi-static stresses, which are distributed close to the dam abutment, were of low magnitude and of no practical importance for the dam. (See also W91-09807) (Fish-PTT) W91-09806

EARTHQUAKE STRESSES IN ARCH DAMS: II. EXCITATION BY SV-, P-, AND RAYLEIGH

Energoprojekt, Belgrade (Yugoslavia), S. B. Kojic, and M. D. Trifunac. Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 117, No. 3, p 553-574, March 1991. 9 fig, 7 ref.

Descriptors: \*Arch dams, \*Dam stability, \*Earthquake engineering, \*Seismic waves, \*Stress analysis, Canyons, Dam foundations, Earthquakes, Mathematical equations

The earthquake response of arch dams induced by nonuniform motions of the canyon walls was stud-ied with respect to the cross-stream and vertical nonuniform motions of canyon walls caused by body SV-, P-, and surface Rayleigh waves. Using a two-dimensional wave equation, the motion of an irregularly shaped canyon was computed. To illustrate only the basic physical phenomena in the dam response associated with 'closing,' 'opening,' and 'out of phase' motions of canyon walls, examples of the responses of an idealized arch dam type 5 to transient SV-, P-, and Rayleigh waves were examined. It was found that accelerations and displacements along the canyon walls depend on the fre-quency and the incidence angle (for SV-waves and P-waves) of the arriving motions. Vertically-arriving SV-waves induce vertical out-of-phase motion and horizontal in-phase motion of the opposite canyon walls. The dam response to this motion favored the antisymmetric modes of vibration. Many components of the quasi-static stresses caused by nonuniform canyon displacements were larger than the dynamic stresses induced by nonun-iform canyon accelerations. The dynamic stresses were less severe for transient Rayleigh surface waves, but the quasi-static stresses were found to be of similar order of magnitude as for transient be of similar order of magnitude as for transient SV-waves. Smaller stresses were induced by transient P-waves, and the smallest by transient SH-waves, with nonuniform canyon motion in the upstream-downstream direction. In general, the dynamic stresses can be larger and distributed differently, then those caused by the corresponding ferently than those caused by the corresponding uniform canyon accelerations. (See also W91-09806) (Fish-PTT)

#### 8F. Concrete

PROPERTIES OF CEMENT MADE FROM SLUDGE.

Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering. For primary bibliographic entry see Field 8G. W91-09388

#### Materials—Group 8G

CHECK OF THE RELIABILITY OF CONCRETE DAMS DURING THEIR CONSTRUCTION AND OPERATION.

For primary bibliographic entry see Field 8G. W91-09467

ALKALI-AGGREGATE REACTION IN CONCRETE DAMS.

Centro di Ricerca Idraulica e Strutturale, Milan

M. Berra, and P. Bertacchi.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 4, p 12-16, April 1991. 3

Descriptors: \*Concrete dams, \*Concrete technology, \*Concretes, \*Dam failure, Aggregates, Alkalinity, Bases, Concrete additives, Concrete construction, Concrete mixes, Concrete repair, Concrete testing, Dam construction, Dam inspection, Dam stability, Dams, Hydraulic engineering, Potassium, Silica, Silicates, Sodium.

Concern has been increasing in recent years about the problems experienced at various concrete dams as a result of alkali-aggregate reaction (AAR).

AAR is a reaction between the hydroxyl ions
associated with the alkalis (sodium and potassium)
in the pore fluid within the concrete, and certain forms of reactive aggregates. According to the type of reactive components in the aggregates, three main categories of reactions can generally be recognized: alkali-silica reaction (ASR), with amorphous silica; alkali-silicate reactions, with polyphasic silicates; and alkali-carbonate reaction lyphasic silicates; and alkali-carbonate reaction (ACR), with dolomitic carbonates. The ASR is the most widespread reaction, causing a gelatinous silica hydrate product which tends to swell and induce expansions with microcracking, deteriora-tion, mass movements, and displacements. The time when damage first appears in concrete varies from a few months to several years after construc-tion, depending on when the reactants first come into contact, on the chemical intensity, and on the environmental conditions. The reaction ceases when either the reactive aggregates or the surfeit of hydroxyl ions are exhausted. The nondestrucof hydroxyl ions are exhausted. The nondestruc-tive ultrasonic pulse technique is sometimes used to provide evidence in addition to visual observa-tions, but only sampling and laboratory investiga-tions can assist reliably in the final assessment. All repair measures, such as replacement of major spalled areas with a concrete patch, gunite, and epoxy coating, or a reinforced concrete facing and resin injections in the cracks, should be considered temporary except in cases where the reaction has been completed. Dam replacement is the final option. The best solution for minimizing this prob-lem is the adoption of effective preventive measties in a superior of circular hards and physical testing of new concrete structures, and use of low-alkali, blended, or mineral-enriched concrete mixes. The investigations on concrete materials should be planned during the first stages of a dam project (feasibility stage or earlier), so that appropriate studies on the potential AAR problems can be completed in good time. (Fish-PTT)
W91-09795

SEISMIC RESPONSE OF A ROCKFILL DAM WITH AN ASPHALTIC CONCRETE CORE.

Norges Geotekniske Inst., Oslo. For primary bibliographic entry see Field 8A. W91-09797

ARGENTINA PLANS SECOND GENERATION OF RCC DAMS.

Instituto Cemento Portland Argentino, San Martin 1137, 1004 Buenos Aires, Argentina. For primary bibliographic entry see Field 8A.

#### 8G. Materials

PROPERTIES OF CEMENT MADE FROM

SLUDGE. Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.

J. H. Tay, and K. Y. Show. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 117, No. 2, p 236-245, March/ April 1991. 5 fig, 5 tab, 14 ref.

Descriptors: \*Cements, \*Materials testing, \*Recycling, \*Sludge disposal, \*Sludge utilization, \*Wastewater treatment, Compressibility, Density, Durability, Municipal wastes, Portland cements, Pozzolans, Sludge drying.

The disposal of municipal sludge from war treatment facilities presents increasingly difficult problems to highly urbanized cities. Incineration might be a feasible alternative solution for sludge might be a leasible alternative solution for studge disposal, providing a means of producing a re-duced volume of sterile, odorless, inorganic ash. The feasibility of using dewatered sludge mixed with lime to produce a cement-like material after incineration was studied, and the properties of necessaria and the properties of cement made from sludge were investigated. Apparent bulk density tests indicated an increasing trend from 466 to 716 kg/cubic m as the firing duration increased from 5 hour to 6 hours. Based on the pozzolanic activity index results, wh range from 57.6 to 67.2%, the cement was found range from 57.6 to 67.2%, the cement was found to lack pozzolanic activity and thus might not be suitable for use as a pozzolan in portland cement concrete. The cement made from dewatering sludge exhibits a high water demand property which (ranging from 60% to 100%) and is quick setting, with initial setting times of 25 to 40 min. An evaluation of the compressive strengths of the mortar cubes indicated that the cement made with a sludge-to-lime mix proportion of 1:1. fired at morrar cubes indicated that the cement made with a sludge-to-lime mix proportion of 1:1, fired at 1000 C for 4 hours under controlled burning, could be used for general masonry work. Further studies need to be carried out to determine the effects on long-term properties, such as durability, prior to acceptance as a suitable masonry cement. (Brun-one-PTT)
W91-09388

CHECK OF THE RELIABILITY OF CONCRETE DAMS DURING THEIR CONSTRUCTION AND OPERATION.

L. A. Zolotov, A. I. Tsarev, and I. F. Blinov. Hydrotechnical Construction HYCOAR, Vol. 24, No. 7, p 480-485, January 1991. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 43-46, July 1990, 10 ref.

Descriptors: \*Concrete dams, \*Concrete testing, \*Dam construction, \*Dam inspection, \*Measuring instruments, \*Monitoring, Automation, Concrete exchnology, Concretes, Dam stability, Design standards, Hydraulic structures, Mathematical

Observations of concrete dams by means of monitoring and measuring instruments are carried out not only to obtain information for assessing the not only to doubt miormained for assessing the state of the dams during their construction but also to check the design assumptions in the behavior of the dam, to perfect calculation methods, and to accumulate and generalize the observation data for accumulate and generalize the observation data for use in developing standards. To improve the safety monitoring of concrete dams, it is recommended that the following be developed: (1) monitoring programs that enable systematic, correlated obser-vations with mandatory preliminary evaluation of the state of the structure by the operator on the site; (2) diagnostic automated systems for monitoring concrete dams with the use of mathematical models of the behavior of concrete dams; (3) plans for reconstructing the systems of control observa-tions for the purpose of replacing failed and obso-lete instruments and bringing measurement systems into conformity with current requirements; (4) provisions for long-term observations with a pre-scribed accuracy, reliability, and promptness of measurements; (5) measurement methods for determining horizontal movements by means of reverse plumb lines, moisture content of concrete, and replacing geodetic measurement methods on dams; and (6) improved devices and methods for determining the physical and mechanical properties of concrete. (Doria-PTT)

MONITORING SYSTEM DETECTS SMALL LEAKS.

Syndicat des Eaux d'Ile de France, Paris, France. A. Grimaud, and O. Pascal.

Water Engineering and Management WENMD2, Vol 138, No. 1, p 14-15, January, 1991. 1 fig.

Descriptors: \*Leak detection, \*Leakage, \*Monitoring, \*Pipelines, \*Warning systems, \*Water conveyance, Acoustics, Automation, Computers, Data acquisition, Flowmeters, Performance evaluation,

Acoustic detection, or correlation, used successfully for 10 years on small and medium diameter pipes for mobile leak detection, has not until now been for mobile leak detection, has not until now been tested as an ongoing monitoring tactic for large diameter pipes. The prototype was built around an industrial microcomputer with a personal-computer-compatible format. The data acquisition line includes specially designed hydrophone sensors (pass-band 20-4,000 Hz). A 1,250 mm-diameter vaster, distribution line concesses the highways. water distribution line crosses the highway be-tween Paris and Pontoise. Monitoring of this line takes place simultaneously at two levels: flow rate comparison and acoustic monitoring. The comparative flow rate operation is done with two single-cord ultrasonic flowmeters with sensors installed in chambers at the end of each pipe section. Four acoustic sensors are fitted with amplifier units protected in chambers and wired via existing cableways. A special configuration for the pipe sections was needed to neutralize permanent vibra-tions in two steel pipes suspended from the bridge. Nevertheless, the performance levels of the acous-tic system were confirmed. Whatever the section, a simulated leak of 7 cu m/h was detected. The flow-rate alarm automatically triggers the valves isolating the concerned reach, and the correlator alarm transmits a request for urgent intervention.
(Doria-PTT) W91-09770

SEEPAGE INVESTIGATION.

Engineering Associates, Madison, WI. K. Nickels, S. Grant, and D. Christensen. Water Engineering and Management WENMD2, Vol 138, No. 1, p 16-17, January 1991. 1 fig.

Descriptors: \*Hydrologic budget, \*Leakage, \*Measuring instruments, \*Reservoir leakage, \*Reservoirs, \*Seepage, Acoustics, Computer programs, ervoirs, \*Seepage, Acoustics, Computer programs, Dam construction, Dyes, Electrical properties, Electrodes, Geophysical methods, Groundwater, Illinois, Lake Carroll, Soil types, Tracers.

A combination of approaches was used to detect reservoir leakage from Lake Carroll, Illinois. A water balance study yielded a graph of lake level fluctuations for the summer drought using a modi-fied reservoir-routing computer program. To identify underground leakage paths near the shore, a land-based self-potential (SP) survey was conducted near where the groundwater table had been determined to be lower than the lake. The selfpotential survey is a geophysical tool to measure the natural electric potential between two elec-trodes on the ground. Four possible areas of leak-age were identified. Underwater microacoustic detection was used to more precisely locate the lake bottom leaks. This technique involves the detection of very-low frequency water sounds. Two areas of elevated sound were identified, the larger of which corresponded to the area localized in the SP survey, along the reservoir's south abutment. Finally, a dye tracer study confirmed the leakage path between south abutment and the downstream flows. A review of the dam's construction documents showed that near the apparent leak site, protection overburden had been removed from the embankment to build the dam and spillways. The exposed porous bedrock is a likely conduit for the leaks, and can be easily sealed. (Doria-PTT) W91-09771

ALKALI-AGGREGATE REACTION IN CON-CRETE DAMS.

Centro di Ricerca Idraulica e Strutturale, Milan For primary bibliographic entry see Field 8F.

W91-09795

#### Field 8—ENGINEERING WORKS

#### **Group 8G—Materials**

FACTORS CONTROLLING THE LONG-TERM PROPERTIES OF CLAY LINERS. California Univ., Berkeley. Dept. of Civil Engi-

For primary bibliographic entry see Field 5E. W91-10155

LONG-TERM DURABILITY AND AGING OF GEOMEMBRANES. Drexel Univ., Philadelphia, PA. Geosynthetic Re-

search Inst. For primary bibliographic entry see Field 5E. W91-10156

CONSTRUCTION AND PERFORMANCE OF A LONG-TERM EARTHEN LINER EXPERI-MENT.

Illinois State Geological Survey Div., Champaign. For primary bibliographic entry see Field 5E. W91-10157

SUMMARY REVIEW OF CONSTRUCTION OUALITY CONTROL FOR COMPACTED SOIL

Texas Univ. at Austin. Dept. of Civil Engineering. For primary bibliographic entry see Field 5E. W91-10159

GEOMEMBRANE CONSTRUCTION QUALITY

ASSURANCE. GeoServices, Inc., Boynton Beach, FL For primary bibliographic entry see Field 5E. W91-10160

FIELD VERIFICATION OF CLAY LINER HY-

DRAULIC CONDUCTIVITY.
Browning-Ferris Industries, Houston, TX.
For primary bibliographic entry see Field 5E.
W91-10161

ATTENUATING MATERIALS IN COMPOSITE LINERS.

Bucknell Univ., Lewisburg, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.

MORPHOLOGY AND MICROCHEMISTRY OF SOLIDIFIED/STABILIZED HAZARDOUS

Louisiana State Univ., Baton Rouge. Dept. of For primary bibliographic entry see Field 5E. W91-10233

#### 8I. Fisheries Engineering

INVESTIGATION OF PILE ANCHORS FOR FLEXIBLE HYDROBIOTECHNICAL STRUC-TURES.

For primary bibliographic entry see Field 8A. W91-09463

CHEMICAL SUITABILITY OF SUBSTRATES FOR WALLEYE EGG DEVELOPMENT IN THE LOWER FOX RIVER, WISCONSIN.

Michigan Technological Univ., Houghton. Dept. of Biological Sciences. For primary bibliographic entry see Field 5C. W91-09767

CRITICAL STREAM VELOCITIES FOR YOUNG-OF-THE-YEAR SMALLMOUTH BASS IN RELATION TO HABITAT USE.

Wisconsin Univ.-Superior. Center for Lake Superi-or Environmental Studies.

T. D. Simonson, and W. A. Swenson.
Transactions of the American Fisheries Society
TAFSAI, Vol. 119, No. 5, p 902-909, September
1990. 4 fig. 2 tab, 22 ref.

Descriptors: \*Aquatic habitats, \*Bass, \*Critical velocity, \*Fish behavior, \*Streamflow, Adult growth

stage, Energy, Flumes, Food habits, Growth, Growth stages, Juvenile growth stage, Survival.

Relationships were defined between current velocity and displacement of young small-mouth bass, Micropterus dolomieui, from nests, and between velocity and the distribution, swimming, respiration, feeding, and growth of larger young. Young that had recently risen from the nest gravel (7-9 mm standard length, SL) were displaced from field nest sites and from laboratory flumes at low velocities (8 mm/s). Nests in areas of higher velocities (15 mm/s) failed to produce young. Comparison of (15 mm/s) failed to produce young. Comparison of respiration and foraging rates of young fish (16-71 mm SL) in laboratory flumes suggested that the ratio of feeding reward to energy expenditure reached a maximum at current velocities between 80 and 130 mm/s. This velocity range produced maximum growth in the flumes and was also the range most frequented by young (46-116 mm SL) in the Mississippi River. Results suggest that fish position generally corresponds to optimum stream velocities. Adult smallmuth bass nestled in habitat velocities. Adult smallmouth bass nestled in habitat suited for survival of fry, and fingerlings generally occupied areas with velocities optimum for feeding and growth. Results should be useful for further development of models that relate stream flow to habitat use and abundance of smallmouth bass. (Doria-PTT)

DISTRIBUTION OF SHRIMP (PANDALUS BO-REALIS) LARVAE AND HYDROGRAPHIC PATTERN IN THE NORTHERN GULF OF ST. LAWRENCE

LAWRENCE.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
P. Ouellet, D. Lefaivre, and V. Koutitonsky.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 11, p 2068-2078,
November 1990. 7 fig. 3 tab, 31 ref.

Descriptors: \*Gulf of St Lawrence, \*Hydrograph analysis, \*Shrimp, \*Spatial distribution, Animal behavior, Ecosystems, Emergence, Fisheries, Graphical analysis, Larvae, Mortality, Seasonal variation, Statistical analysis.

The large-scale spatial distribution of northern shrimp (Pandalus borealis) larvae was analyzed in the Gulf of St. Lawrence during the spring of 1986 and 1987. Although sites of emergence are related and 1967. Atthiough sites of enlergefice are related to the principal aggregation areas of adult shrimp, currently fished aggregations may not represent isolated populations. The uniformity of developmental stages and the wide spread distribution of the first larval stage were consistent with the hy-pothesis of synchronous larval emergence among the northern Gulf shrimp. The structured pattern of larval spatial distribution was not correlated with the hydrographic structure within the different sectors of the Gulf (Mantel test; P > 0.05). ent sectors of the Gulf (Mantel test; P > 0.05). Spatial correlograms showed that the highly structured spatial distribution pattern of stage I larvae evolved into a spatially readous. evolved into a spatially random pattern by the time stage III larvae had developed. Biological or ecological dynamic processes, such as larval mortality and development rates, are more important than the hydrodynamics of the sectors in determining the structure of larval shrimp distribution. Consequently, on a seasonal basis, the distribution of quenty, on a seasonal basis, the distribution of larval shrimp groups cannot be inferred from a study of the hydrographic pattern within the sector at the present scale. (Author's abstract) W91-09991

TEMPORARY RESIDENCE BY JUVENILE SALMON IN A RESTORED ESTUARINE WETLAND.

Washington Univ., Seattle. Fisheries Research For primary bibliographic entry see Field 2L. W91-09992

IMPACT AND IMPLICATIONS OF LARGE-SCALE ENVIRONMENTAL ANOMALIES ON THE SPATIAL DISTRIBUTION OF SPAWN-ING OF THE NAMIBIAN PILCHARD AND ANCHOVY POPULATIONS.

Sea Fisheries Research Inst., Cape Town (South Africa).

For primary bibliographic entry see Field 2L. W91-10010

CHANGES IN ICHTHYOFAUNAL DIVERSITY AND ABUNDANCE WITHIN THE MBASHE ESTUARY, TRANSKEI, FOLLOWING CONSTRUCTION OF A RIVER BARRAGE.
Transkei Univ., Umtata (South Africa). Dept. of

Zoology. For primary bibliographic entry see Field 6G. W91-10013

#### 9. MANPOWER, GRANTS AND FACILITIES

#### 9A, Education (Extramural)

DEVELOPMENT OF THE HYDROLOGICAL CYCLE IN THE WESTERN WORLD: HOW IT IS TAUGHT IN FRANCE, YESTERDAY AND TODAY (RAPPEL DE L'HISTORIQUE DU CONCEPT DU CYCLE DE L'EAU DANS LA CULTURE OCCIDENTALE: SON ENSEIGNE-MENT EN FRANCE, HIER ET AUJOURD'-HID.

Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). Lab. d'Hydrolo-

gie. Y. L'Hote. Y. L'hote.
IN: Water for the Future: Hydrology in Perspective. IAHS Publication No. 164. International Association of Hydrological Sciences, Washington, DC. 1987. p 37-45, 1 fig, 14 ref. English summary.

Descriptors: \*Education, \*France, \*History, \*Hydrologic cycle, \*Hydrology, \*Reviews, Future planning, Professional personnel, Public participation, Public policy, Social aspects, Water resources development

A brief overview is provided of the conceptual development, with quotations from past writers, and the observations and practices which have led to the present understanding of the hydrologic cycle. The history of the concept of a water cycle has progressed through the Old Testament, the ancient Greeks, the Romans, the Christian and Medieval Epoch, the French Renaissance, and the eighteenth century to the present. In France, only 30 years ago a recognition of the global water cycle did not exist, except for future specialists in course of their university studies. The present system of teaching hydrology in French schools is a good example of a profitable investment. The existence and the fragility of the hydrological cycle as well as the public and private responsibilities are taught in elementary (7 to 11 years of age) and secondary (11 to 18 years) schools. (See also W91-10108)

#### 9C. Research Facilities

SUMMARY OF WATER-RESOURCES ACTIVI-TIES OF THE U.S. GEOLOGICAL SURVEY IN WASHINGTON: FISCAL YEAR 1989,

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09829

#### 9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1989 INSTITUTE PROGRAM REPORT (ARKANSAS WATER RESOURCES RESEARCH CENTER).

Arkansas Univ., Fayetteville. Water Resources Research Center.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-106773. Price codes: A03 in paper copy, A03 in microfiche. Program Report G-1549-01, June 1990. 36p. USGS

#### Grants, Contracts, and Research Act Allotments—Group 9D

Contract No. 14-08-0001-G1549. USGS Project No. G-1549-01.

Descriptors: \*Arkansas, \*Information transfer, \*Research, \*Training, \*Water resources institutes, Education, Projects.

Four of the major water resource problems/issues in Arkansas are: (1) nonpoint source contamination of water; (2) efficient septic systems and wastewater treatment plant operation; (3) wetland studies; and (4) lowering of ground water levels in eastern and southern Arkansas and possible associated salt water contamination. There were six projects funded under Section 104 by the Arkansas Water Resources Research Center during FY 1989. A total of 14 students (7 undergraduates and 7 graduate) gained training in these projects. Two of the projects were related to agriculture. One deals with optimal reservoir design for conjunctive use of ground and surface water. The other developed a simulation model for the fate of nitrogen in Four of the major water resource problems/issues oped a simulation model for the fate of nitrogen in open a simulation model for the fate of nitrogen in poultry litter. Two projects dealt with septic tank (virus removal) and wastewater treatment plant effluent effects on water quality. A fifth project studied dew (and frost) chemistry in relation to rain. The sixth project has developed a technique for photographing algal taxa and inclusion of the photographs into an ecological data base for Arkansas. (Steele-U. AR, Fayetteville)

#### FISCAL YEAR 1989 REPORT (NEW HAMP-SHIRE WATER RESOURCES RESEARCH CENTER).

New Hampshire Univ., Durham. Water Resources Research Center.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-106781. Price codes: A03 in paper copy, A03 in microfiche. Report G1576-02, September 1990. 37p. USGS Contract No. 14-08-0001-G1576. USGS Project No. G1576-02. T. P. Ballestero.

Descriptors: \*Information transfer, \*New Hampshire, \*Research, \*Training, \*Water resources institutes, Education, Projects.

This report covers the activities of the New Hampshire Water Resource Research Center for the period July 1, 1989 through June 30, 1990. The results of six research projects are briefly dis-cussed. Projects include: effects of the forest land cussed. Projects include: effects of the forest land application of municipal wastewater treatment plant sludge, estimation of low stream flows on ungaged watersheds, evaluation of coliform bacteria and enteric virus pollution in surface waters, development of landfill siting criteria and a solid waste management model, evaluation of the treatwaste management model, evaluation on the treat-ment potential of soils to ash landfill leachate and the in situ biodegradation of gasoline in ground-water. These projects address the state's water problems of water quantity, water contamination, water treatment and waste disposal. (Ballestero-Univ. NH-WRRC) W91-09474

## FISCAL YEAR 1989 PROGRAM REPORT (UTAH CENTER FOR WATER RESOURCES

Utah Water Research Lab., Logan.

L. D. James.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-106757. Price codes: A03 in paper copy, A03 in microfiche. Report G1593-02, September 1990. 27p, 1 fig. USGS Contract No. 14-08-0001-G1593. USGS Project No. G1593-01.

Descriptors: \*Information transfer, \*Research, \*Training, \*Utah, \*Water resources institutes, Education, Projects.

Within FY 1990 the Utah Water Research Laboratory received approximately \$4 million in water tory received approximately 34 million in water research support for 14 program areas. Four programs were augmented with USGS funds administered through the Utah Center for Water Resources Research. Since the current USGS program began in 1988, 18 projects have augmented

studies on a number of topics important to the state and conducted at UWRL and elsewhere on campus. The current projects were also chosen to foster interdisciplinary interaction. One project ex-amined fundamental meteorologic and surface and groundwater processes in closed desert basins to obtain information that can be used to better manage the limited water and sparsely developed manage the limited water and sparsely developed land resources around desert playas. A second project sought deeper understanding of anaerobic biotransformations that can be used in protecting ground water supplies from toxic organic chemicals (largely petroleum-related in Utah). The third evaluated linking remote sensing with computer modeling in estimation of temporally and spatially variable soil moisture conditions in a mountain watershed. And the fourth project optimized groundwater withdrawals from an aquifer underlying a major urban area to prevent contamination ing a major urban area to prevent contamination from overlying polluted shallow aquifers. (James-Ut. St. U.-UCWRR) W91-09475

## FISCAL YEAR 1989 PROGRAM REPORT (OHIO WATER RESOURCES CENTER). Ohio State Univ., Columbus. Water Resources

R. C. Stiefel.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-106765. Price codes: A03 in paper copy, A03 in microfiche. Report G-1607-02, August, 1990. 36p., 2 fig. USGS Contract No. 14-08-0001-G1607. USGS Project No. G1607-02.

Descriptors: \*Information transfer, \*Ohio, \*Research, \*Training, \*Water resources institutes, Education, Projects.

Water is one of Ohio's most important natural resources, and the State has an adequate supply to meet its immediate needs. Most of Ohio's water problems are associated with quality. Of primary concern are the sediments, nutrients and acids in the surface waters from urban, agricultural and mining areas, and the toxic and hazardous wastes that threaten the ground and surface waters. The focus of the 1989 State Water Research Program was directed at some of these needs. One project explored the design criteria for an innovative two-stage fluidized bed bioreator in which the three major processes of cell immobilization, biodegradation, and biofilm control were combined in a single unit. This innovative, reliable biological water treatment process and design provides an efficient and environmentally safe wastewater an encient and environmentally sare wastewater treatment system. Two projects explored the fate and transport of agricultural chemicals. One stud-ied the potential impacts interactions and reactions between herbicides and existing humic materials as they move through the soils toward the ground-water table. The other project studied in the bewater table. The other project studied in the behavior of nitrogen-heterocyclic compounds as they break down in the soil and their persistence in an aquifer. The fourth project studied the Scioto River buried valley aquifer. This research developed a groundwater management model for predicting water quality changes associated with groundwater abstraction. (Stiefel-OH State U.)

## FISCAL YEAR 1989 PROGRAM REPORT (OKLAHOMA WATER RESOURCES RE-SEARCH INSTITUTE).

Oklahoma State Univ., Stillwater. Univ. Center for

Water Research.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-107060. Price codes: A04 in paper copy, A04 in microfiche. Program Report G1608-01, September 1990. 44p. USGS Contract No. 14-08-0001-G1608. USGS Project No. G1608-01.

Descriptors: \*Information transfer, \*Oklahoma, \*Research, \*Training, \*Water resources institutes, Education, Projects

The FY 1989 Oklahoma Water Resources Research Institute research program addressed the issues of surface and groundwater quality and man-

agement of water resources with emphasis on the determination of water quality and remediation of water resources determined to be contaminated. Research projects funded by the OWRRI to address these issues included: an investigation of the risks to groundwater quality associated with pestirisks to groundwater quality associated with pesti-cide use; the development of gamma ray tomogra-phy for imaging soils and their transport pathways;the improvement of parameter estima-tion for hydrologic/water quality models; the es-tablishment and characterization of biofilms capa-ble of degrading 2,4-d; an investigation into the effects of agricultural practices on water quality; an investigation into predicting water characteris-tic curves for unsatured soils from its bulk densian investigation into predicting water characteristic curves for unsaturated soils from its bulk densify and particle size distributions; and an evaluation of the use of microorganisms with elevated enzyme activity as a potential in-situ aquifer restoration technique. Information transfer activities included: continued publication of the newsletter; publication of a directory of academic, public and private water resources professionals in the state, a brochure explaining the programs of the water center, and a flyer listing water research projects; participation in an information transfer workshop; and presentation of a water conservation program to a presentation of a water conservation program to a children's group. (Durham-OK State U.)
W91-09477

#### FISCAL YEAR 1989 PROGRAM REPORT (OREGON WATER RESOURCES RESEARCH INSTITUTE).

Oregon State Univ., Corvallis. Water Resources Research Inst.

B. P. Warkentin.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-107052. Price codes: A03 in paper copy, A03 in microfiche. USGS Contract No. 14-08-0001-01609. USGS Project No. G1609-02.

Descriptors: \*Information transfer, \*Oregon, \*Research, \*Training, \*Water resources institutes, Education, Projects.

The FY 1989 Oregon Water Resources Research Institute program included four research projects addressing critical water problems in Oregon. Two projects in their second year of support by the Institute advanced our ability to predict suitable habitat for fish from landscape and stream features: Project 02, Riparian and Geomorphic Regulation of Abundance and Distribution of Salmonids in Pacific Noteshweet Streams and Project 03 Cumpul. of Adultance and Distribution of Sambonius in Pacific Northwest Streams, and Project 03, Cumu-lative Impact of Riparian Cover on the Thermal Loading, Trophic Processes, and Juvenile Steel-head Trout in Small Streams of the John Day head Trout in Small Streams of the John Day Basin. Project 04, Quantifying Losses of Nitrogen for Land-Applied Dairy Manure, measured amounts lost through the different pathways, in-cluding leaching to groundwater. The sites are on dairy farms with high cattle: land ratios, where excess nitrogen is often applied. Baseline data on mass of a glacier can be used to follow long term climate changes. Project 05 was set up to get such measurements for an Oregon glacier. Annual meas-urements will be continued with other funds. The FY 1989 Oregon WRRI program also included FY 1989 Oregon WRRI program also included education and training activities for 33 graduate students, 2 undergraduate students from across campus in WRRI seminars plus 11 graduate students, 8 undergraduates and 6 high school students dents, a undergraduates and o fight school students in research training on WRRI projects. Informa-tion transfer activities, answering telephone and mail inquiries, presenting information at meetings with water managers, and participation in meetings with water managers, and participation in floorings with water management agency personnel were an important part of the WRRI program. (Warkentin-OR State U.-WRRI) W91-09478

#### FISCAL YEAR 1989 PROGRAM REPORT (PENNSYLVANIA CENTER FOR WATER RE-SOURCES RESEARCH).

Pennsylvania State Univ., University Park. Center for Water Resources Research.

A. J. McDonnell.

A. J. McDonnen. Available from National Technical Information Service, Springfield, VA 22161 as PB91-107045. Price codes: A03 in paper copy, A03 in microfiche.

#### Field 9—MANPOWER, GRANTS AND FACILITIES

#### Group 9D—Grants, Contracts, and Research Act Allotments

USGS Contract No. 14-08-0001-G1610. USGS Project No. G1610-01.

Descriptors: \*Information transfer, \*Pennsylvania, \*Research, \*Training, \*Water resources institutes, Education, Projects.

Three projects and a program of technology transfer were conducted under the Fiscal Year 1989 State Water Resources Research Grants Program State water Resources Research Grants Program (PL 98-242, SECT. 104). Issues addressed focused on improved methodologies for the delineation and management of non-point source pollution. In a completed study an assessment was made to identify priority NPS pollutants for developing watersheds in Pennsylvania. Seven different pollutant wash-off functions were developed by application to simulated rainfall-runoff experiments conducted to simulated rainfall-runoff experiments conducted in a rainfall simulation facility. In a continuing study, improved methodologies are being developed to use geographic information systems to facilitate diagnostic assessment performed with existing software renditions of mechanistic hydrologic models. A study was also initiated to monitor and model a test watershed for hydrologic and water quality response as related to soil type, geology, topography and land use practices. Groundwater quality education dominated the Institute's technology transfer program during Fiscal Year 1989. (McDonnell-Penn State U.)

FISCAL YEAR 1989 PROGRAM REPORT (WISCONSIN WATER RESOURCES CENTER),
Wisconsin Univ.-Madison. Water Resources

Center.
G. Chesters.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-106799. Price codes: A03 in paper copy, A03 in microfiche. USGS Contract No. 14-08-0001-G1599.

Descriptors: \*Information transfer, \*Research, \*Training, \*Water resources institutes, \*Wisconsin, Education, Projects.

The FY 1989 Wisconsin Water Resources Center's program consisted of the Director's Office program, seven research projects and an information dissemination/technology transfer program. As in recent years, the program has focused on ground-water quality research, which has been deemed a priority item nationally, regionally and at state and local levels. The Water Resources Reference Servlocal revers. The water Resources Reterence Services continued to maintain and expand its collection. During FY 1989 the collection grew to more than 19,500 cataloged technical reports, about 8,500 cataloged reprints and reprints on eutrophication were donated to the library and are being integrated into the collection. The retrieval and dissemination of water-related information has benefitted university faculty, staff and students and state agency personnel, state legislators and other state agency personnel, state legislators and other decisionmakers, private consultants, environmental groups and the general public. The Water Resources Center continued to provide support and training for undergraduate and graduate students. During FY 1989 eight graduate students, three undergraduate students and two post-doctoral research associates were supported on WRC projects. (Sherman-WI Water Res.Ctr.)

### FISCAL YEAR 1989 PROGRAM REPORT (ARIZONA WATER RESOURCES RESEARCH

CENTER).
Arizona Water Resources Research Center,

Available from National Technical Information Avanaoie from National Technical Information Service, Springfield, VA 22161 as PB91-136275/ AS. Price codes: A03 in paper copy, A03 in micro-fiche. Program Report G1548-01, October 1990. 36p, 5 tab. USGS Project No. G1548-01.

Descriptors: \*Arizona, \*Information transfer, \*Research, \*Training, \*Water resources Institutes, Education, Projects.

The research projects supported by the 1989 Pro-gram addressed the following critical water issues

in Arizona: conjunctive water management (project 02 and 03), and groundwater quality (project 04). Project 02 (continuing) is designed to identify the conjunctive and integrated water management option for the Phoenix Active Management Area which maximizes total benefits from all sources of water less total costs of groundwater overdraft, enforcement of water rights, and opportunity costs. Project 03 is intended to develop a honwledge have and analysis tools that can be used knowledge base and analysis tools that can be used knowledge base and analysis tools that can be used to assess the advantages of conjunctive water management on urban watersheds in Arizona. Project 04 provides a state-of-knowledge assessment intended to evaluate existing model equations for their capacity to predict fate and transport of organisms in groundwater. The information transfer components of the institute continued to publish accordance of the control of the con newsletters and issue papers, sponsored or co-sponsored workshops and conferences, and increased its outreach activities. (USGS)

FISCAL YEAR 1989 PROGRAM REPORT (WY-OMING WATER RESEARCH CENTER).

Wyoming Univ., Laramie. Water Resources Research Inst. S. P. Gloss

S. P. Gloss.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-136267/
AS. Price codes: A04 in paper copy; A04 in microfiche. Program Report G1600-01, July 1990. 57p.
USGS Contract No. 14-08-0001-G1600. USGS
Project No. G1600-01.

Descriptors: \*Information transfer, \*Research, \*Training, \*Water resources Institutes, \*Wyoming, Education, Projects.

Four research projects were funded under the FY89 program, as well as an information transfer program. Two projects funded through the WWRC state grants program were submitted as matching. A short statement identifying each project follows: (1) A technique is presently being tested which will lower the alkalinity of solid waste materials from mining refinery processes to make them more susceptible to reclamation; (2) Uncertainty analysis and risk evaluation was performed on parameters of a dissolved oxygen (DO) water quality model which show that DO prediction depends on the classification of the stream and the use of a correct probability distribution; (3) the use of a correct probability distribution; (3) Microorganisms which inhabit the rhizosphere are found to play a major role in the modification of the bioavailability of selenium; (4) An evaluation of potential toxicity effects of saline discharges from potential toxicity effects of saline discharges from oil production operations on a portion of a stream system in Wyoming has indicated that these saline discharges significantly contribute to observed tox-icity; and (5) Matching-funds projects are: the study of hydrologic, geomorphic and biologic re-sponses of conveying municipal water through an ephemeral watercourses; and the maintenance of a high mountain watershed observatory for the purngh mountain watersmet observatory to poses of hydrologic, water quality, and climatolo-gic research and educational instruction. Informa-tion transfer was accomplished through field tours, tion transfer was accomplished through ned fours, professional papers, a newsletter, law journal publications, seminars and updating data and bibliographic information sources. (Gloss-WY Univ.-WWRC)
W91-09560

FISCAL YEAR 1989 PROGRAM REPORT (WASHINGTON WATER RESEARCH CENTER).

Washington State Water Research Center, Pull-

W. H. Funk. Available from National Technical Information Service, Springfield, VA 22161 as PB91-136259/ AS. Price codes: A03 in paper copy; A03 in micro-fiche. Program Report G1597-01, August 1990. 23p, 1 tab. USGS Contract No. 14-08-0001-G1597. USGS Project No. G1596-01.

Descriptors: \*Information transfer, \*Research, \*Training, \*Washington, \*Water resources Institutes, Education, Projects.

Water is a key resource in the development of the Pacific Northwest and Washington State. Nineteen

dams and hydropower systems provide 80% of the power needs of the region. Water from the Columbia-Snake River watersheds irrigate over 4.9 million acres of farmland. The 50,000 miles of streams 8,000 freshwater lakes play a major role in social, recreational, and economic structure of the social, recreational, and economic structure of the state. A major commitment of the state water agencies and the public is to preserve the migration of anadromous fishes in Pacific Northwest rivers as well as enhance the recreation value and save well as enhance the recreation value and save usage of the surface water and groundwater. Recent droughts have shown that under low-water conditions allocations are not sufficient for all users. Funding from the State Water Research Institute Program allowed researchers working through the State of Washington Water Research Center to evaluate the criteria proposed by the Timber/Fish/Wildlife group to classify streams. TFW is a program to minimize losses of fisheries and wildlife while utilizing resources. Other concerns studied included the movement of pesticides through various soils under different soil, environmental, and cultural conditions in order to develop better predictive models. Investigations were carried out on the toxicity of a herbicide, triclopyr, on a non-target aquatic organism. Studies were made on increasing the germination of a plant species, Agropyron spicatum, to enhance vegetation over the loess soils of semi-arid erosive lands. The State the loess soils of semi-arid erosive lands. The State of Washington Water Research Center program is directed toward informing, educating, and attempting to solve or mitigate these complex water contamination, allocation, use and reuse issues. These goals are carried out through publication of research results, conferences, workshops, and presentations. The Water Research Center publishes an annual 'plain text' report summarizing all research carried out through the Center during that year. In addition, newsletter and brochures are produced for distribution to agencies and the public. (Funkfor distribution to agencies and the public. (Funk-WA St. U-WRC) W91-09561

FISCAL YEAR 1989 PROGRAM REPORT (MINNESOTA WATER RESOURCES RE-SEARCH CENTER).

Minnesota Univ., St. Paul. Water Resources Research Center.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-136242/ AS. Price codes: A04 in paper copy; A04 in micro-fiche. Program Report G1570-01, August 1996 68p. USGS Contract No. 14-08-0001-G1570. USGS Project No. G1570-01.

Descriptors: \*Information transfer, \*Minnesota, \*Research, \*Training, \*Water resources Institutes, Education, Projects.

The report summarizes activities of the University of Minnesota Water Resources Research Center for fiscal year 1989, covering the Period July 1, 1989 through June 30, 1990. The report describes results of research projects sponsored by the center, its information transfer and coordination activities, and its involvement in training water resources scientists and engineers. During this period, the Center funded seven projects through its federal grant program. Four of the FY 1989 projects were in their second (and final) year, and completion reports are in preparation for publica-tion in early 1991. The Center organized and cosponsored two conferences on major water responsored two conferences on major water re-sources problems in Minnesota during FY 89 and published a proceedings for one of them. The Center also commissioned a study (with nonfederal funds) to review methods of assessing sensitivity of groundwater aquifers to contamination by human activities at the land surface, and a draft report of the study was submitted at the end of the 1989-90 program year. The report is in review and will be published by the Center in fall of 1990. (Brezonik-U. MN) W91-09562

FISCAL YEAR 1989 PROGRAM REPORT (TEXAS WATER RESOURCES INSTITUTE). Texas A and M Univ., College Station. Water

#### Reference and Retrieval—Group 10B

W. R. Jordan.

Available from National Technical Information Available from National Technical Information Service, Springfield, VA 22161 as PB91-136234/ AS. Price codes: A03 in paper copy; A03 in micro-fiche. Program Report G1592-01, November 1990. 31p. USGS Contract No. 14-08-0001-G1592. USGS Project No. G1592-01.

Descriptors: \*Information transfer, \*Research, \*Texas, \*Training, \*Water resources Institutes, Education, Projects.

The program included 5 research and 1 technology transfer projects and focused on surface water quality, impacts of pesticides on aquatic ecosystems and management of rural water supply systems. Significant findings were: atrazine and bitems. Significant innuings were: atrazine and oi-fenthrin did not act synergistically on natural aquatic communities, therefore their combined ef-fects could be predicted from effects of individual chemicals; sediment transport by rivers into Gulf Coast estuaries was not related to either phase of Coast estuaries was not related to either phase of the hydrograph or to water viscosity, but large flows were the principal source of sediment; water conservation in various dairy operations can reduce fresh water use by over 50%, thereby reducing the quantity of wastewater and reducing the risk of surface water contamination; small rural the risk of surface water contamination; small rural water systems are under both technological and financial stress and are most likely to violate Health Dept. standards. The technology transfer project produced 4 issues each of Texas Water Resources and New Waves. (Jordan-Texas A&M W91-09563

FISCAL YEAR 1989 PROGRAM REPORT (VIRGIN ISLANDS WATER RESOURCES RE-SEARCH CENTER).
Caribbean Research Inst., St. Thomas, VI. Water

Resources Research Center.

J. Hari Krishna. J. Hari Krishna.
Available from National Technical Information
Service, Springfield, VA 22161 as PB91-136226/
AS. Price codes: A03 in paper copy; A03 in microfiche. Program Report G1595-01, November 1990.
20p. USGS Contract No. 14-08-0001-G1595.
USGS Project No. G1595-01.

Descriptors: \*Information transfer, \*Research, \*Training, \*Virgin Islands (US), \*Water resources Institutes, Education, Projects.

The major thrust of the Virgin Islands Water Resources Research Center Program during FY 1989 was in the area of water quality. The following three studies dealing with various aspects of water quality were conducted: Occurrence of Legionella in cistern water systems; Microbiological quality of bottled water; and Bacteriological studies to evalu-ate the safety of recreational waters. Information are the salety of recreational waters, information transfer activities included the publication of the proceedings of the Virgin Islands Water Resources Conference, publication of technical and capsule reports pertaining to the studies conducted in FY reports pertaining to the studies conducted in FY
88, participation in professional meetings, and cosponsorship of the International Symposium on
Tropical Hydrology and Fourth Caribbean Islands
Water Resources Congress. (Hari Krishna-U.
Virgin Is.-WRRC)
W91-09564

FISCAL YEAR 1989 PROGRAM REPORT (LOUISIANA WATER RESOURCES RE-SEARCH INSTITUTE).

Louisiana Water Resources Research Inst., Baton

W D Constant

W. D. Constant.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-136218/
AS. Price codes: A04 in paper copy; A04 in microfiche. Program Report G1565-02, November 1990.
59p. USGS Contract No. 14-08-0001-G1565-02.
USGS Project No. G1565-02.

Descriptors: \*Information transfer, \*Louisiana, \*Research, \*Training, \*Water resources Institutes, Education, Projects.

The 1989 cooperative research program of the Louisiana Water Resources Research Institute

(LWRRI) addressed priority water resources prob-lem areas identified for Louisiana-management of surface water supplies, groundwater control and restoration, and wastewater treatment alternatives. Four research projects funded to address these Four research projects funded to address these priority issues were: (1) Nature and Rates of Bacterial Metabolism in the Aquifers of Southeastern Louisiana; (2) Aquaculture/Marine Fisheries Process Wastewaters; (3) The Importance of Denitrification to the Efficiency of Wastewater Treatment in Forested Wetlands; and (4) Field Testing of Rock-Reed Filters for Small Domestic Wastewater Flows. Cooperative efforts, both in research and information transfer, were expanded in Fiscal Year 1989. Joint activities between the Institute and state agencies and between the Institute and other state agencies and between the institute and other university organizations were enhanced. During FY 1989, the directorship of LWRRI changed from Dr. Marty Tittlebaum to Dr. W. P. David Constant. There have been significant efforts by the Director to enhance coordination of LWWRI research with other units at LSU and the state. The Advisory Board was restructured for FY 1990. to focus the research program. The Director estab-lished mile stones for the Institute to enhance growth. (Constant-LA St U-LWRRI) W91-09565

FISCAL YEAR 1989 PROGRAM REPORT (NORTH DAKOTA WATER RESOURCES RE-SEARCH INSTITUTE). North Dakota Water Resources Research Inst.,

Fargo. R. C. Schnell.

R. C. Schnell.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-136192/
AS. Price codes: A03 in paper copy; A03 in microfiche. Program Report G1581-02, July 1989. 21p.
USGS Contract No. 14-08-0001-G1581. USGS Project No. G1581-02.

Descriptors: \*Information transfer, \*North Dakota, \*Research, \*Training, \*Water resources Institutes, Education, Projects.

The six projects selected for funding for FY 1990 were concerned with various aspects of water quality; detection and quantitation of organic solutes, alteration of contaminants, pollution profiles of nature runoff, and recycling of urban lagoon water. Projects 02 and 03 are developing state-of-the-art methodology to detect and quantify organic solutes. Radioimmunology was developed to detect and lacer by the ground in the ground, surface, and wastewater in Minnesota and North Dakota. Detectable arounts were found in surface, states past The six projects selected for funding for FY 1990 wastewater in Minnesota and North Dakota. Detectable amounts were found in surface water next to fields of potatoes and sugar beets. In the second project, methodology for detection is being developed by combining supercritical fluids chromatography with electric chemical detection using microelectrobes (SFC/ESD). Project 04 explored the use of ettringites to form oxyanions for use in abatement, remediation, alteration of contamination of water by As, B, Mo, Se, V. Studies were conducted to examine the formation of the compounds and the conditions required for such formation. Project 05 was concerned with evaluating the pollution profile of runoff water in Fargo-Moorhead. Results indicated that some pollutants occurred in concentration. head. Results indicated that some pollutants oc-curred in concentrations exceeding surface water curred in concentrations exceeding surface water standards, thus runoff can intermittently impair water quality and contribute to generally deterio-rated conditions. Project 06 explored the possibili-ty of determining financial feasibility in recycling sewage lagoon water into a potable water supply. Preliminary results indicate that this can be finan-cially feasible. Project 07 was designed to deter-mine if natural abundance 15N techniques were feasible for distinguishing sources of nitrate con-tamination in coarse textured soils with shallow reasine for distinguishing sources of intrate con-tamination in coarse textured soils with shallow groundwater. Apparently, the methodology is suf-ficient to provide hypothesized detection. One graduate student was supported by a fellowship from the NDWRRI. The project evaluated the effects of a complete fishkill in a large, shallow, eutrophic lake. Information transfer activities ineutrophic lake. Information transfer activities in-cluded: sponsoring WET workshops, co-sponsor-ing a North Dakota Groundwater Quality Sympo-sium, publication of technical reports, and scientif-ic manuscripts, and presentations at national meet-ings. Six students (1 undergraduate, 2 M.S., 3 Ph.D) were supported by funding in the projects of this grant. (Schnell-ND St U)

W91-09566

FISCAL YEAR 1989 PROGRAM REPORT (CONNECTICUT INSTITUTE OF WATER RE-

Connecticut Univ., Storrs, Inst. of Water Re-

D. R. Miller

D. R. Miller.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-162875. Price codes: A03 in paper copy; A01 in microfiche. Report G 1552, November 1990. 40p. USGS Contract No. 14-08-0001-G1552. USGS Project No.

Descriptors: \*Water Resources Institutes, \*Connecticut, \*Research, \*Information transfer, \*Training, Education, Projects.

Connecticut's Institute of Water Resources 1989-90 research and information projects focused on water quality management and protection, resources data, the water cycle and surface waters. sources data, the water cycle and surface waters, Funded research projects included: implications of contaminant transport for well head protection; (02) modeling potential effects of climatic variability on the hydrologic regime of forested watersheds; (03) development of a cell culture-based assay for aquatic pollutants; (04) a survey to quantify the amount of general use pesticides in Connecticut; (05) paleohydrology of upland stream (06) a groundwater action/education project; and a study on how best to control diatom blooms in reservoirs. Information transference conference study on now best to control diatom blooms in reservoirs. Information transference conference and seminar topics included: Connecticut's upland contribution to pollution in Long Island Sound, a Quinnipiac River conference, advanced treatment for metal-bearing waste minimization, and surface water management. There was also a project to design and illustrate a series of field-identification charts on aquatic invertebrates. (USGS) W91-09862

FISCAL YEAR 1989 PROGRAM REPORT (IOWA WATER RESOURCES RESEARCH IN-STITUTE)

Iowa State Water Resources Research Inst., Ames.

Iowa state water resources research inst., Ames. W. W. Sanders.

Available from National Technical Information Service, Springfield, VA 22161 as PB91-162883.

Price codes: A03 in paper copy; A01 in microfiche.

Report No. G-1562-01, 1990. 34p. USGS Project

Descriptors: \*Iowa, \*Water Resources Institutes, \*Research, \*Information transfer, \*Training, Education, Projects.

The Iowa State Water Resources Research Institute FY 1989 research program (University of Iowa and Iowa State University) was funded by the Department of the Interior, U.S. Geological Survey. The research program was centered in an area critical to Iowa's natural resource program area critical to rows in natural resource program pertaining to water, namely, nitrogen and pesticide transformation, fate and transport in groundwaters and surface waters. Two projects were continued from FY 1988 and the include: (1) an evaluation of transformation, fate and transport of nitrogen in agricultural streams; and (2) biotransformation of agricultural streams; and (2) hold assistantiation pesticides and toxic chemicals in the subsurface environment under aerobic, anoxic and methanogenic conditions. (Sanders-IA St. U.)
W91-09863

#### 10. SCIENTIFIC AND TECHNICAL INFORMATION

#### 10B. Reference and Retrieval

SELECTED REFERENCES FOR THE PUGET-WILLAMETTE LOWLAND REGIONAL AQUIFER-SYSTEM ANALYSIS, PUGET SOUND LOWLAND, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
M. A. Jones.

#### Field 10—SCIENTIFIC AND TECHNICAL INFORMATION

#### Group 10B—Reference and Retrieval

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-584, 1991. 55p, 1 fig.

Descriptors: \*Bibliographies, \*Aquifer systems, \*Regional Aquifer-System Analysis (RASA), \*Puget Sound Lowland Aquifer, \*Willamette Valley Aquifer, \*Groundwater resources, \*Washington, \*Oregon, Puget-Willamette Lowland.

The Puget-Willamette Lowland regional aquifer system is located in western Washington, western Oregon, and a small part of southwestern British Columbia, Canada. The regional aquifer system is composed of two distinct aquifer system or subareas, the Puget Sound Lowland and the Willamette Valley. The Puget-Willamette Lowland is one of the regional aquifers being studied under the U.S. Geological Survey's nationwide Regional Aquifer-System Analysis Program. This study is the first comprehensive regional assessment of the groundwater resources of the Puget-Willamette Lowland. As a preliminary step in the comprehensive study, a literature search was made and bib-The Puget-Willamette Lowland regional aquifer Lowland. As a preliminary step in the comprehensive study, a literature search was made and bibliographies compiled of selected references on the hydrology for each of the subareas. This report provides a bibliography for the Puget Sound Lowland aquifer system. It includes studies of the groundwater resources, glacial geology, geochronology, geophysics, structural geology and tectonics, surface water, evapotranspiration, and other pertinent subjects. (USGS)

#### 10C. Secondary Publication And Distribution

WATER RESOURCES PUBLICATIONS FOR

ALABAMA, 1857-1990. Geological Survey, Tuscaloosa, AL. Water Resources Div

E. A. Meadows, and H. H. Jeffcoat. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-567, 1990. 53p.

Descriptors: \*Alabama, \*Publications, \*Water re-Descriptors: "Alabama, "Publications, "Water re-sources, Coal mining effects, Ecology, Floods, Ge-ology, Groundwater, Hydrology, Model studies, Sedimentology, Sinkholes, Springs, Streamflow, Surface water, Waste disposal, Water availability, Water quality, Water use.

This report consists of a bibliography of water-resources publications for Alabama published since 1857 by the U.S. Geological Survey and two State agencies, the Geological Survey of Alabama and the Alabama Highway Department. The bibliogra-

phy includes an alphabetical listing of publications by author, and cross-referenced indexes by county, general areas of the State, subject and type of report. (USGS) W91-09490

BIBLIOGRAPHY OF SELECTED WATER-RE-SOURCES PUBLICATIONS ON NEVADA BY THE U.S. GEOLOGICAL SURVEY, 1885 THROUGH 1990.

Geological Survey, Carson City, NV. Water Resources Div. For primary bibliographic entry see Field 7C. W91-09836

U.S. GEOLOGICAL SURVEY TOXIC SUB-STANCES HYDROLOGY PROGRAM: AB-STRACTS OF THE TECHNICAL MEETING, MONTEREY, CALIFORNIA, MARCH 11-15,

Geological Survey, Reston, VA. For primary bibliographic entry see Field 5B. W91-09843

#### 10F. Preparation Of Reviews

HISTORY OF THE WATER RESOURCES DI-VISION OF THE UNITED STATES GEOLOGI-CAL SURVEY: VOLUME V, JULY 1, 1947, TO APRIL 30, 1957.

Geological Survey, Reston, VA G. E. Ferguson.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Special Publication, 1990. 328p, 7 fig, 8 tab, 12 ref.

Descriptors: \*US Geological Survey, \*Water resources research, \*History, Hydrologic data, Data collections, Research and development.

This is the fifth in a series of volumes that record This is the fifth in a series of volumes that record the history of the Water Resources Division of the U.S. Geological Survey, but it is the first to be published as a public document. Volume V provides much greater coverage of the national program and organization of the Division than preceding volumes, which were essentially accounts of activities of the District offices. The publication for public use of the first four volumes remains one of the Division's goals. (USGS)

VARAHAMIHIRA, THE EARLIEST HY-

Nagpur Univ. (India). Dept. of Geology.

K. S. Murty

IN: Water for the Future: Hydrology in Perspec-tive. IAHS Publication No. 164. International As-sociation of Hydrological Sciences, Washington, DC. 1987. p 11-15, 6 ref.

Descriptors: \*Biographies, \*History, \*Hydrology, \*India, \*Reviews, Clouds, Groundwater resources, Plant growth, Rain gages, Scientific personnel, Vegetation, Water supply development.

Varahamihira (AD 505-587) was an Indian scientist whose fields of specialization ranged from medicine and surgery to mathematics. He was an astrologer, an astronomer, and a hydrologist and he deals with all these subjects in his magnum opus, Brihat Samhita. On the formation of clouds, he gives the properties of the rainy season and relates the movement of planets through stars/constellations to the formation of constants. Varahamihira (AD 505-587) was an Indian scientist gives the properties of the rainy season and relates the movement of planets through stars/constellations to the formation of clouds. Raingaging appears to have been prevalent in India from very early times. According to Varahamihira, rain should be measured after the full-moon day of the month of Jyestha (May-June) when it has rained in the hold of the through the properties of the properties of the control the phase of the moon commencing with Purva-sadha. Varahamihira expounds on the subject of exploration for underground water and springs, referring to the art of water divinity. He says that water falls from the sky with the same color and taste, assumes various colors and tastes owing to the difference in the nature of the earth. The the difference in the nature of the earth. The presence of water was ascertained mainly through the presence and type of vegetation, e.g. presence of a certain tree in a waterless tract, sometimes accompanied by an ant-hill or a snake's abode. Varahamihira could indicate the occurrence of water below the surface at depths ranging from 3.43 to 171.40 m with the help of various plants and grass varieties. He quotes earlier works, which are not available now, but Brihat Samhita establishes him as the first hydrologist who codified all the then existing knowledge on the subject. (See also W91-10103) (Fish-PTT) W91-10105

DEVELOPMENT OF THE HYDROLOGICAL CYCLE IN THE WESTERN WORLD: HOW IT IS TAUGHT IN FRANCE, YESTERDAY AND TODAY (RAPPEL DE L'HISTORIQUE DU CONCEPT DU CYCLE DE L'EAU DANS LA CULTURE OCCIDENTALE: SON ENSEIGNEMENT EN FRANCE, HIER ET AUJOURD'-HID HUD.

Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). Lab. d'Hydrolo-

For primary bibliographic entry see Field 9A. W91-10108

### SUBJECT INDEX

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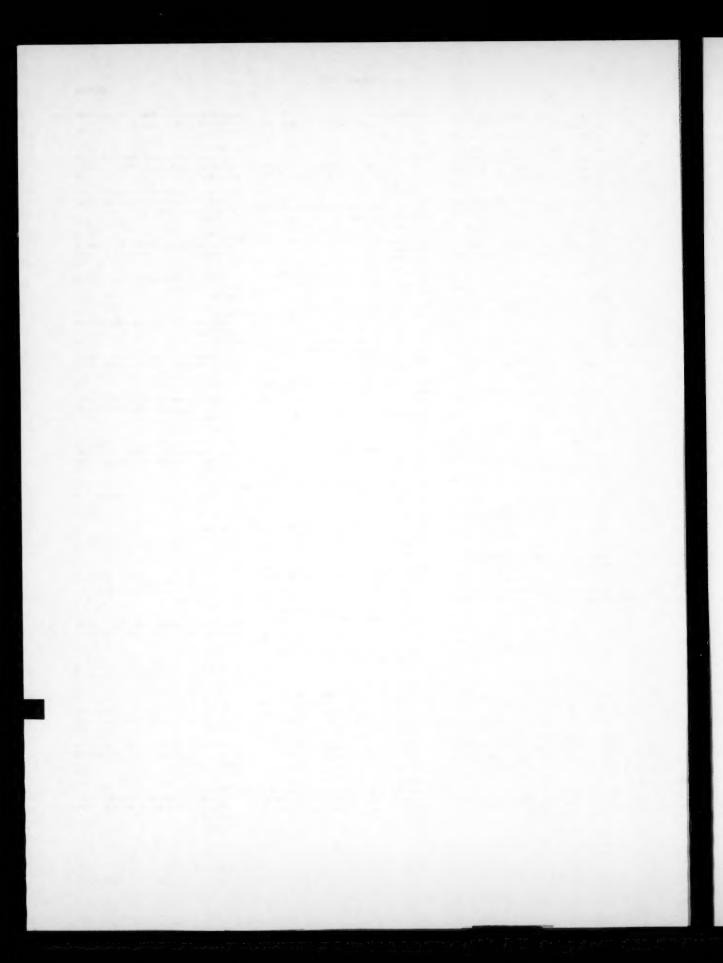
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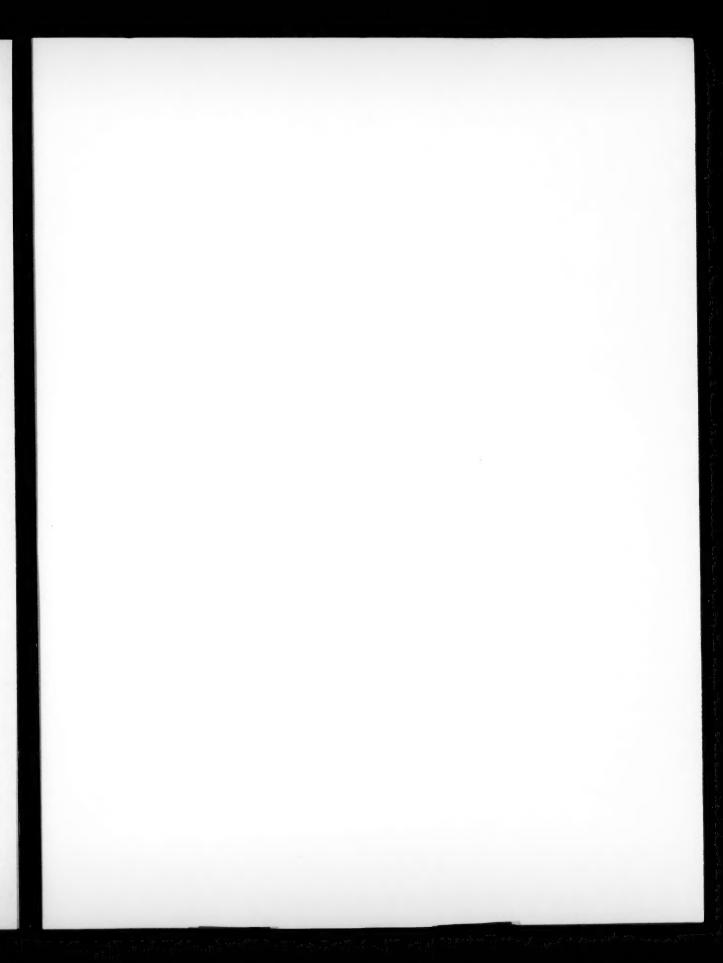
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#### NTIS Price Schedules for the U.S., Canada, and Mexico

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A01\$9.00	E01\$11	D01\$55	T01\$180
A02 12.50	E02 14	D0290	T02240
A03 17.00	E03 16	D03 140	T03360
A04-A05 19.00	E04 19	D04 195	T04 480
A06-A09 26.00	E0521	D05 250	T05 590
A10-A13 35.00	E0624	D06300	T06710
A14-A17 43.00	E0727	D07 360	T07 820
A18-A21 50.00	E0830	D08 410	T08940
A22-A25 59.00	E09 33	D09 460	T091,050
A99	E1036	D10520	T101,160
	E1139	D11570	T111,270
	E12 43	D12 630	T12 1,390
"N" Codes	E13 46	D13 680	T13 1,500
N01\$60.00	E1450	D14740	T14 1,620
N0259.00	E1554	D15790	T15 1,740
N03 20.00	E1659	D16840	T16 1,850
1400	E17 64	D17 890	T17 1,960
	E18 69	D18950	T182,080
	E19 76	D19 1,000	T192,190
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